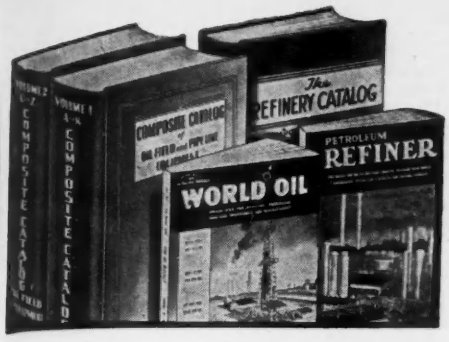

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THE UNHOLY TRIPLETS

By RAY L. DUDLEY, Publisher

WHILE it is becoming less popular, day by day, for a Communist to sell his wares openly in the U. S. and many other countries, there still remain many who, under the mis-label of "Liberals" are attempting to peddle some of the doctrines of totalitarian Russia under false names used to disguise their origin.

We have said many times in the past that Communism, Fascism and Nazism were triplets spawned by the same serpent father and mother. Today more and more Americans and nationals of other countries are coming to hold the same belief. The end result of the three, Communism as practiced in Russia, Nazism as followed in Germany, and Fascism as inflicted on Italy, has been destruction of individual rights, oppression of the masses, and misery for all but the self-chosen few whose word is law.

Yet we find people, all over the world, urging policies which are identical with the prime policies of the unholy triplets.

A few days ago we read that the famous liner Normandie, in preparation as a troop-ship in New York harbor, is now known to have been set afire by Nazi spies disguised as American workmen. The guile of disguise is as ancient as history, and as effective as the serpent's bite. It is, therefore, no surprise that the stratagem should be employed in peacetime. The wonder to us in connection with the preachments of Communism is two-fold—first, that apparently well-meaning people could be found to deliver them; second, that well-meaning people could be taken in by them.

Our confidence in human nature would indeed be shaken if we believed that all who preach communistic doctrines are paid agents of Russia whose imperialistic motives are daily becoming more apparent. Then we take refuge in two thoughts. One is that the theory of brotherly love, which is supposed to be the basis of Communism, appeals to most of us, and maybe some are so smitten with the theory that they ignore the actual results as found in Russia. The other is that some people are just plain dumb!

Because, what has the Russian totalitarian system, operating under the name of Communism, to offer the peoples of a free country?

Food? Russia, since the days of the Bolshevik revolution, has been notoriously a land of hunger, despite a film to the contrary a few years ago, now denounced even by some of its participants as pure propaganda.

Clothing? Russia has been a land of scarcity for years. One has only to read books or articles by those who escaped, to know of the shortages.

Individual Freedom? No, the concentration camps of Russia, filled with those in non-agreement with the powers to be, or even those suspected of such non-agreement, give the lie to the fable of individual freedom.

Brotherly love? No, the ideology of those who call themselves "Communists" is a doctrine of hate.

No, what Russia has to offer is a sorry substitute for what is found in a free country.

So when someone offers the suggestion that there is something better than the overall fruits of individual enterprise, of the capitalistic system . . . which after all is simply a system under which private ownership, of homes, of industry, of professional life, is the basic principle . . . stop and ask yourself:

"Does he want me to accept the Russian idea? Is he by chance offering me the alternative of Socialistic Britain?

"What does he have to offer me that is better than the right to work in my chosen field, to be able to buy the products of others with the products of my own efforts?"

After all, "By their fruits ye shall know them!" And the really fruitful nations are those where the citizen controls the state—not where the state controls and keeps in subjection the citizen.

We think there will never be a chance for Communism to win the revolution of bullets and blood they speak of in secret places—but since it is the Russian hope to divide and demoralize its opponents by guile and dissension, let us recognize these efforts to mislead for what they are, even though the "misleaders" are misled themselves.

THE BAKER *Triplex* CEMENTING SHOE does an important job...and does it well!

The "Triple" purpose of the Baker TRIPLEX Cementing Shoe is to pack-off in large-diameter, or irregularly-shaped holes, retain all cement slurry above the shoe, and protect permeable, low-pressure formations below from cement contamination.

All cement slurry is directed upward through side whirler ports. A sleeve-type, resilient rubber back-pressure valve opens readily to permit passage of the slurry into the annulus around the shoe, but closes instantly to prevent any return flow of slurry. The Baker Metal Petal Basket is intended to form a bridge, thus preventing cement slurry from settling into permeable, low-pressure zones below The Basket is indispensable in large-diameter, or irregular-shaped holes.

The Baker TRIPLEX Cementing Shoe (Product No. 136) operates as a conventional float shoe while running-in the casing. Then, after reaching the desired point in the hole, circulation is established through the ample interior passageway of the shoe, and the hole is conditioned preparatory to cementing. The Tripping Ball now is pumped (or allowed to gravitate) down the hole to seat upon the Tripping Valve. A pressure of 400 to 500 psi is applied to the casing which shears the screws in the Tripping Valve, permitting it to move downward and expose the cementing ports. Shearing these screws also releases the hold-down strap around the basket, allowing the basket to expand outwardly against the wall of the hole. The cementing operation is then carried out in the conventional manner with all cement slurry directed upward and held above the shoe by the expanded Baker Metal Petal Basket.

The Baker TRIPLEX Cementing Shoe consists of a whirler float shoe with a Baker Metal Petal Basket fastened on the shoe below the cementing ports. All internal parts are made of readily drillable materials. Two one-half inch set screws hold the inner assembly stationary to facilitate drilling out the shoe.

Contact your nearest Baker office or representative for details and recommendations.

BAKER
OIL TOOLS

BAKER OIL TOOLS, INC., LOS ANGELES • HOUSTON • NEW YORK

The Changing Panorama

Wanted: Scrap Steel From Europe

WHILE THE use of oxygen to increase steel production without correspondingly heavy investment in steel-making facilities (except, of course, the oxygen plants) holds a ray of light, there is little hope for substantial relief soon in steel supply unless the quantity of scrap steel is increased.

Consequently, every oil man who is looking for more pipe to carry on his operations has a heavy stake in the proposition of getting more scrap.

There seems to be a real possibility of increasing the scrap pile if the U. S. government takes a realistic view on the situation.

The Marshall plan calls for the shipment of scrap *to* Europe, whereas the process ought to be reversed and scrap should be coming *from* Europe to the U. S.

Every person with whom we have talked recently, who has returned from Europe, says Europe is a veritable junk heap.

"I saw miles on miles of tanks, which will never run again," said one oil man recently returned. Another spoke of seeing other material—made of steel—in tremendous quantities. Still others have confirmed the story.

Why not bring a lot of this scrap back to the U. S.? Our ships will be going over with supplies furnished as a part of the Marshall plan, or a modified form of it. They will come back empty—in spite of the fact that European nations want exports and dollar credits. This scrap could provide at least *one* form of export. Its collection would provide at least *some* employment.

While this scrap is rusting in Europe and North Africa, American steel mills are short of scrap, and American industry, which must provide a part of the taxes to carry out the Marshall plan, and the employment which will provide still more taxes, is crying for steel.

There seems to be only one thing wrong with the idea of getting this scrap back to the U. S.; it has too much horse sense in it to commend it to some, though we hope not all, bureaucrats.

Let's start something to get the scrap moving this way.

Hand of Fellowship Extended by Nomads

A NOTEWORTHY appreciation of international relations was shown during the Chicago API session at an impromptu meeting of Nomads, that organization of representatives of American oil field equipment manufacturers who sell abroad.

By a unanimous vote they passed a resolution asking their board of regents to call attention to the need of special attention being paid to visitors from abroad at the coming International Petroleum Exposition.

The Housing Committee of the Exposition in Tulsa has promised to make special housing arrangements for such visitors. Many of these visitors will be representatives of foreign governments, men connected with bureaus relating to petroleum, and the Nomads feel that the Exposition should exercise every care to provide hotel rooms in keeping with the positions of importance these men hold.

Incidentally, it was brought out in a report by the Tulsa Chapter of Nomads, that the new building being constructed as headquarters for foreign visitors on the Exposition grounds will be an important addition to the Exposition facilities and that provision will be made to have present persons who will be able to speak any language used by the visitors from abroad.

Building Good Will And Saving Fuel Oil

THE POSTWAR boom in the oil industry has exceeded all predictions. Drilling is higher than predicted, production exceeds the highest estimates, and demand is above the most extravagant figures advanced. Most critical at this moment is the high demand for fuel oil, which, according to the October issue of Shell *News* is up 20 percent this season. Reasons listed were (1) approximately 400,000 new oil furnaces were installed in homes during the first seven months of the year and that figure is increasing; (2) demand from industrial sources increased substantially.

The industry is credited with doing all in its power to meet the needs for fuel oil. But it is clear that many consumers of fuel oil will go wanting.

However, a study of the situation shows that there are additional measures which would save a substantial volume of fuel oil. This saving could be derived through more efficient operation of heating units requiring oil. Because the heating units of industrial plants are engineered to extract a maximum of heat from the oil, little saving could be expected from this source.

A large potential saving in fuel oil could be derived from a careful consideration of heating losses and requirements for residential units, which are not so closely enginered. Shell *News* illustrates 29 different measures the home owner could take to save fuel. These recommendations range from closing house doors promptly to installing storm windows in severe climates. As much as 50 percent of fuel burned could be saved, it stated, through efficient combustion of oil heaters. An additional 10 percent could be saved by reconstructing fire boxes according to modern designs. From these suggestions, it is seen that hundreds of thousands of barrels of fuel oil could be saved this winter by more efficient use of heat in the home.

The oil industry as a whole has much at stake in this winter's fuel oil shortage. How will families in cold homes feel toward the industry's public relations campaign? Perhaps the industry could benefit by making recommendations to the home owner on how to get more for his heating dollar. Not only will he help himself live more comfortably through the winter, he will make it possible for his neighbor to have fuel as well. The net results of such a program would be to the advantage of the oil industry. It might stave off much criticism.

"People who want natural gas for cooking or heating or industrial uses are going to have to pay a high enough price, within a few years, to keep the gas they want from becoming gasoline."

Max W. Ball, director, Oil and Gas Division, U. S. Department of the Interior.

HOWCO . . . ROTO-WALL CLEANER
Increasing use of the Howco Roto-Wall Cleaner emphasizes its advantages. With Roto-Wall cleaners and casing head swivel installed, the pipe is rotated while the cement is being placed. Without restricting the flow of fluid, the Howco Roto-Wall Cleaner removes mud from the wall, prevents channeling, centers casing and assures equal distribution of cement.
Result: A better cementing job . . .
Ask your nearest Howco representative for particulars, or write for Bulletin No. 7.
HALLIBURTO OIL WELL CEMENTING CO.
DUNCAN, OKLAHOMA

MONTHLY NEWS ANALYSIS

Industry enters trying period. . . . Demand for oil products rises
Supplies allocated on Atlantic Seaboard. . . . Controls threatened
Europe to get oil and equipment. . . . Further price hikes posted

THE petroleum industry faces a particularly tough and trying period. With winter at hand the demand for oil products in November began rising toward the higher levels predicted for January and February of next year, and it became necessary to institute allocation of supplies in the Atlantic Seaboard area. Consequently, the threat of insufficient oil supplies to meet prospective record consumption became a reality, with the shortage due to grow steadily worse during the next three months.

The long-range viewpoint also grew dimmer as indications developed to warn that demand would be greater in the next several years than heretofore had been anticipated. Consequently, the problem of supplying enough oil to meet world demand apparently is to be with the industry for several years.

With the U. S. government preparing to combat inflationary movements, it became apparent that the industry's present position makes it a vulnerable target for those seeking to reestablish government controls on industry.

High Demand Makes Allocation Of Supplies Necessary

Although production and refining are at such record levels that available capacity is being taxed to the limit, the petroleum industry is scarcely able to fill all demand.

As early as the past summer it was necessary in the Midwest for refiners to allocate supplies of gasoline to dealers and in turn for dealers to allocate supplies among consumers. Such allocations were still being applied in the Midwest in November.

Furthermore, in mid-November, similar allocations of supplies of gasoline and other products were inaugurated in New England and the Middle Atlantic states. Socony-Vacuum Oil Company initiated the Eastern allocations by establishing quotas of gasoline, diesel fuels, kerosine, and heating oils for dealers and direct customers. The seriousness of the situation in this area was reflected by Socony-Vacuum basing its quotas for gasoline, naphthas and diesel fuels on a basis 4 percent less than the quantities delivered in November and December of 1946.

To prevent chilly homes as much as possible, oil-using customers were given priority over diesel fuel consumers, and Socony's allocations for kerosine and heating oils will be on the basis of deliveries made from June 1, 1946, to May 31, 1947. Besides being the most drastic allocation system yet adopted by any major oil company in the East, Socony's allocation of supplies was the first to draw a definite distinction between products.

The company will announce its allocation program for the early months of 1948 by mid-December. It appears certain that some form of allocation will be necessary, perhaps an even more drastic one.

Standard Oil Company of New Jersey began gasoline allocations on the Eastern area in October. These were intended to effect the most equitable distribution of products not in ample supply. It is hoped they will help hold shortages of oils to local and temporary character.

Supplies of gasoline, kerosine and distillates in the area east of the Rocky Mountains may fail to meet estimates of demand by about 5 percent during the next seven months, John W. Boatwright of Standard Oil Company of Indiana, told the API marketing group. He pointed out that if the industry concentrated on meeting the fuel oil demand, it would be short on gasoline; but that if it concentrated on gasoline, fuel oil production would fall short of needs.

Shortage Problem to Exist For Several More Years

It is becoming more and more apparent that the industry's problem of providing enough supplies to meet consumption probably will exist until at least 1951. Demand still is climbing, and although oil industry expansion goes forward, new facilities will merely help to keep supply in line with even greater consumption during the next several years.

Tight markets and high prices apparently are here to stay for a considerable time. As fast as the industry can hope to expand the output of petroleum products, demand will absorb these additional supplies.

In an address before the American Petroleum Institute's annual session, Oscar L. Chapman, Undersecretary of the Interior, and other speakers, emphasized the very high prevailing levels of demand and the expectation of even greater consumption ahead in pointing out the gravity of the current problem of supplying enough petroleum products.

Domestic demand for petroleum in 1948 will approximate 5,700,000 barrels per day, predicted Chapman, equivalent to 608 gallons per person, compared with demand of only 367 gallons per capita in 1938, an increase of 65 percent since the last prewar year. Outside the U. S. total demand in 1948 is estimated at 3,300,000 barrels daily, if that much is available, compared with 3,033,000 barrels in 1947 and 2,127,000 daily in 1938. While world demand is thus estimated at 9 million barrels daily in 1948, it will in all probability reach 10 million barrels daily in 1950 or perhaps even in 1949, Chapman predicted. This is approximately double the world demand of 1938.

"In approximately 80 years prior to 1938 the petroleum industry built capacity to supply the world with about 5 million barrels a day of oil products," Chapman added. "But now it is called on to double its capacity between 1938 and 1949 or 1950, and thus to do in a dozen or so years what previously took nearly 80 years to accomplish."

Between now and 1960, the demand for oil outside the U. S. and Russia will increase by 1,800,000 barrels per day or 67 percent and thus amount to 4,500,000 barrels daily, forecast B. Brewster Jen-

American Austerity

A shortage of gasoline in the New Jersey area, near some of the East's largest refineries, has caused a return to a form of rationing by gas station operators.

—Acme Photo.

nings, president of Socony-Vacuum Oil Company at the API annual meeting, in discussing the international petroleum situation. This would compare with 3,200,000 barrels daily predicted in 1950, approximately 2,700,000 daily in 1947, and 1,900,000 daily in 1938. "By comparison," Jennings added, "the U. S., now consuming about 5,400,000 barrels daily, is expected by 1960 to require 6,800,000, an increase of 1,500,000 barrels daily or 28 percent. In other words, oil consumption in Europe is expected to increase at a rate much faster than in the U. S." Adding the Jennings forecasts of foreign and domestic demand, it is found that he expects by 1960 a total world demand for 11,300,000 barrels of oils per day, not including Russia. This would be an increase of 3,200,000 barrels a day or practically 40 percent over the current world demand of 8,100,000 barrels daily, exclusive of Russian consumption.

The Harriman Committee studying the requirements of Europe also reported difficulties would be encountered in supplying as much oil as the European-aid program now contemplates. The committee estimated that U. S. consumption would reach 6,167,000 barrels daily by 1951. Asserting that present world shortage of oil is "so serious" that estimated requirements may be as much as 5 to 10 percent short in 1948, the committee foresaw conditions growing worse and the possibility that the shortage might rise to 10-15 percent in 1949, 15-20 percent in 1950, and improve to only 10-15 percent behind requirements by 1951.

Situation Creates Fear of Government Controls

The difficulties being experienced by the petroleum industry in meeting record consumptive requirements, coupled with proposals for establishment of government controls to curb the inflationary spiral, could easily lead to imposing of controls on oil almost as severe as during the war. To deal with shortage of oil, steel and food, many government officials now are urging export controls, allocations for domestic use, regulation of transportation and distribution, and the curbing of speculation and hoarding.

So far as oil is concerned, the clamor for controls no doubt will increase sharply during the next few months, especially if some parts of the country suffer because of insufficient fuel supplies.

The dangers created by this situation were aptly described by Undersecretary of the Interior Oscar L. Chapman before the annual meeting of the American Petroleum Institute, when he warned:

"Even 1 percent of our population is nearly 1½ million people, and 1½ million people chilly or out of work for lack of fuel oil, even for short periods, or unable to harvest their crops for lack of gasoline, will expect remedial action. Rightly or wrongly, many of them will demand that the government do it or see that it is done. The pressure on the administration and the Congress to institute some sort of government control, whether allocation or rationing or something else, may not easily be brushed aside."

Government Controls Seen As Being Impractical

API President William R. Boyd flatly rejected all suggestions that the federal government should take some action in the present petroleum supply situation, saying the industry itself can do a far better job. This view was expressed by other industry speakers at the annual API meeting.

Mandatory oil controls were termed impractical by Interior Undersecretary Oscar Chapman. "Mandatory controls increase cost, slow down service and generally interfere with the normal fluidity of competitive business which naturally finds and supplies new and usual demand and, just as naturally, shuts off supplies where they are no longer needed," Chapman declared. "Not only that," he continued, "but any such interference with the normal trade practices creates further areas of hardship and demands for still further interference."

Chapman listed six "common objectives" for the industry to try and attempt in this order of urgency:

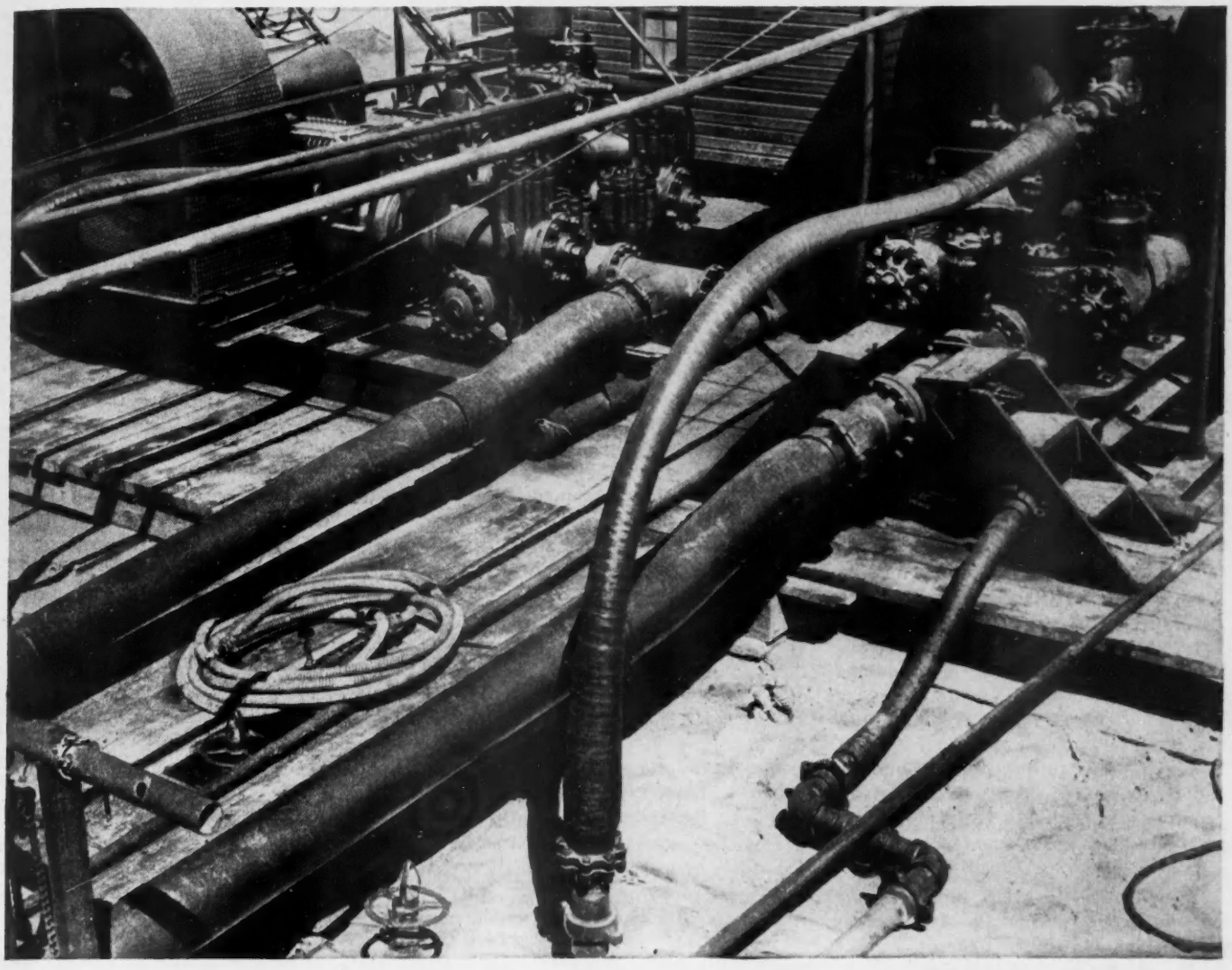
1. Supply essential government needs, including the armed forces.
2. Supply public utilities.
3. Supply fuel to heat homes.
4. Provide adequate farm fuel.
5. Supply fuel oil-burning and gasoline-consuming industries.
6. Supply, insofar as possible, the pleasure gasoline used by Americans.

Aid to Europe Program Will Require Oil and Equipment

Although Congress may take several months to debate aid to Europe in the present special session, devoted primarily to that proposition, it is generally agreed that Congress will commit the U. S. to a Marshall Plan or its equivalent. On this assumption, a stimulation of shipments of American-controlled oil and American-made oil industry equipment into Western Europe is foreseen.

Because of such anticipated shipments, problems will be raised as to how it will be possible to meet the domestic and export requirements of oil and materials used by the oil industry. Besides the problems peculiar to the oil industry itself, the industry also will be affected by the impact of the program upon the national economy in general, since the aid-to-Europe effort will be quite similar to the wartime economy, though directed toward reconstruction rather than the prosecution of war.

Among the oil men who have made



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No need to tell you that oil drilling demands hose that can take punishment.

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You can see, in the picture above, an actual performance of Monarch Mud Pump Suction Hose and Monarch Flexible Discharge Hose. They are feeding mud from slush pit to mud pump to standpipe.

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What's more, you will find its tube is made of special purpose synthetic rubber built to resist oil. Leakproof, built-in couplings—developed by Hewitt—assure an unrestricted fluidway throughout the entire hose length.

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Write today for detailed information. Or consult your nearest Hewitt distributor:
Mid-Continent Supply Company • Norvell-Wilder Supply Company • Jarecki Manufacturing Company Standard Supply & Hardware Company • Bethlehem Supply Company of California • Knight Manufacturing & Supply Company

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He's always ready to serve you. And he knows your job . . . your operations . . . your problems. Call on him at any time for advice. He'll recommend the exact Hewitt product especially designed to help *improve* the efficiency of your operations.

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Monarch Rotary Drilling Hose

public their views on aiding Europe is B. Brewster Jennings, President of Socony-Vacuum Oil Company, who discussed the subject at considerable length in an address on "The International Petroleum Situation," at the annual meeting of the API November 12. "It is my view," he said, "that the Marshall Plan, suitably safeguarded, should be put in effect. The consequences of a failure to do so are practically a certainty and contrary to the vital interest of our country. If it is implemented there is a strong probability that it will accomplish its objective of preserving the democracies of Western Europe.

"The oil industry has a grave responsibility with regard to a large and vital part of the plan," Jennings added. "We must, therefore, so conduct our affairs that our industry will be able to perform efficiently when it is called upon. I wish to emphasize that by and large the steps necessary to make available the large amount of oil needed in Europe do not conflict with the long-term requirements for oil at home. Both the Eastern and Western hemispheres are going to consume petroleum in rapidly growing quantities and both require that supplies be augmented promptly from new sources at home and abroad.

"The really important thing for the oil companies, as for all of us," continued Jennings, "is that there be peace in the world and that another war be avoided. As individuals, as companies, and as a nation, we must work together to the utmost of our ability to further this end . . . As individuals, as companies, and, I hope, as a united industry, we will advocate policies that are designed to advance the interest of a free and democratic world society."

The Committee of European Cooperation in its report called for "dollar oil" in the amount of $2,187,000,000 over the four years 1948-1951 and $555 million worth of oil industry equipment. "Dollar oil" does not mean solely oil to be exported from the U. S. While shipments of small amounts of U. S. lubricating oils and other special products unobtainable elsewhere are contemplated, most of the "dollar oil" will be shipped from sources outside the U. S. but require payment in dollars. Geographically, the shipments will not differ materially from former movements. "However," declared Jennings, "it is expected that under the Marshall Plan the volume of oil and oil equipment moving into the 16 nations will be greater than it has been, and surely it will be greater than would be possible if no plan is authorized."

Jennings declared that oil will be highly important in carrying out a program of assistance to Europe and that the oil industry has a very real responsibility to so conduct its affairs that this vital help may be given. "To fully discharge that responsibility," he said, "we are going to have to take the broad view, not the narrow one. With vastly more oil needed in the immediate future, we must take bold steps, and do those things which will contribute the most for a given expenditure of material and labor in making oil available."

Since oil is highly essential for improving conditions in Europe and since the U. S. has no substantial exportable oil resources, any such program as the Marshall Plan likely will actively encourage prompt development of Middle Eastern oil resources for European use and also promote use of Caribbean oil in Europe pending expansion of Middle East facilities.

World Tanker Shortage To Become More Severe

The world shortage of tankers, a major factor in the scarcity of petroleum products in different sectors of the world, including the Atlantic Seaboard of the U. S., is to become more critical during the next few months when larger quantities of petroleum are needed than ever before.

This condition has caused tanker rates to rise sharply, and further increases in rates appear certain. The U. S. Maritime Commission was able to cover only about half of the 256 coastwise liftings requested by commercial operators during November. This was in addition to full coverage given Navy's coastwise requirements of 19 voyages.

Present rates on privately owned large tankers on single voyage basis have skyrocketed to about double current USMC rates. The latter, once recognized as the going price in world tanker market, now has little influence. Private tanker rates undoubtedly will go even higher as more government ships are sold to private operators, thus reducing the influence of USMC on the world tanker situation. Even at existing high rates, tankers are very difficult to obtain.

Expanded Public Relations Program Is Approved

Seeing the present position of the industry as making it necessary to expand and intensify the oil industry's public relations program, the board of directors of the API approved plans to raise $1,855,000 for such work in 1948.

The new program calls for an increase in national advertising which the industry inaugurated in August of 1947, and contemplates an expansion of the number of district public relations offices and an increase in the number of field representatives.

A highly important phase of the 1948 program calls upon the oil companies to include favorable publicity for the industry in company advertising.

In connection with the public relations program, both Institute President William R. Boyd, Jr., and John M. Lovejoy, chairman of the API public relations committee, emphasized the importance of harmony within the industry and tolerance of its members towards each other.

Within the industry, vigorous competition is to be encouraged, said Lovejoy, but controversy should not be allowed to culminate in unjustified charges or attacks that cast reflection upon the integrity of the industry. On the same subject, Boyd asserted: "Oil men have too much work to do—producing, refining, transporting, and distributing oil—to fritter away their energy in family squabbling that ordinarily does little more than give encouragement to those who would mess up our industry."

Especially is there danger, Boyd added, in seeking government intervention in controversial affairs within the industry, because this is the way to government controls.

Over 1000 oil companies are now actively participating in the program, and at least 40 oil trade associations are supporting it. But it is necessary, said Lovejoy, to widen this area of participation and to obtain widespread financial support to assure success of the program.

Further Increases in Prices Are Posted

Oil industry prices last month continued to reflect the inflationary forces of insufficient supplies and abnormal cost factors of the prevailing war-disrupted world economy. Holding the line on oil prices, given up as an impossibility in the Mid-Continent at mid-October, also failed to last through October on the Pacific Coast.

In that region prices of heavier grades of crude were increased October 28 by 10 cents a barrel, and product prices subsequently were adjusted proportionally. At the close of October there also were increases in crude and product prices in Canada. Turner Valley crude was raised 20 cents a barrel, and other fields were given increases of 10 to 27½ cents. In the southwestern Ontario fields of Eastern Canada, crude price postings were advanced 30 cents a barrel.

...REPAIR
at HOUSTON
The Byron Jackson Plant at 6247 Navigation Boulevard, Houston
View of Machine Shop
View of Assembly Shop

Looking Ahead

CRUDE OIL prices may be increased further in the not distant future. Despite the October 20-cent per barrel increase in crude prices, there has been a rapid reappearance of premiums or bonuses above the posted price schedules. Premiums ranging from 5 to 20 cents per barrel are again becoming common with small refiners, especially in the Gulf Coast area. Past experience shows that when such premium payments become general, the posted price of crude oil goes up.

BY 1970 expect gasoline made from coal; 43 million passenger automobiles against the present 27 million; consumption of 17 barrels of gasoline per car per year; even greater expansion in use of trucks and commercial vehicles; increased use of kerosine, diesel fuel and domestic heating oil; total demand for 2 billion barrels of crude oil or its equivalent against 1¼ billion in 1945. So predicted George Roberts, Jr., research division, Stanolind Oil & Gas Company, Tulsa, before Independent Natural Gas Association at Oklahoma City in late October.

COAL-BURNING gas turbines, if successfully developed, might tend to crowd out diesel-electric locomotives where coal supplies are moderately priced, although diesels currently are capturing the bulk of the vast locomotive replacement market.

THE COMING half-century will bring vast industrialization and population growth in western U. S., based on plants for making gasoline and gas from that region's huge coal reserves, predicts A. C. Powel of Westinghouse Electric. By such plants, he added, burning of coal in lumps will be outmoded, and the coal will be used instead as liquid or gas.

AN ELECTRONIC tracer, working directly from blueprint or original drawing, replaces the customary template for oxyacetylene cutting of involved shapes. Development of this system into a rugged field unit should greatly speed up both original fabrication and maintenance in both production and pipe line operations.

TO EXPAND crude oil producing and handling capacity by 1 million barrels per day, as will be needed within a few years, the petroleum industry will have to invest $3 billion, it is estimated; and to expand and modernize refining capacity to supply minimum demand for 87-97 octane motor fuel will require another $3 billion.

CALIFORNIA will have to import crude oil within two or three years, with demand even now 73 percent above prewar, largely due to great industrial activity. Exports are down to 70,000 barrels daily from 170,000 a day prewar and will virtually cease by 1952. These were forecasts made by Robert L. Minckler, executive vice president, General Petroleum Corporation, before the AIME meeting in Los Angeles.

NOW IN the experimental stages, furnaces are being developed which are expected to extend greatly the scope of petroleum wastes as fuel. Some furnaces will burn asphaltic pitch, petroleum coke and acid sludge, while others are equipped to consume high-sulfur fuels without the usual concurrent corrosion hazards.

ANGLO-IRANIAN Oil Company, Standard Oil Company (N. J.), the Royal Dutch-Shell group, Gulf Oil Corporation and The Texas Company rank in the order named in ownership of petroleum reserves. The U. S. contains only 38.3 percent of world reserves, but foreign holdings boost U. S.-controlled reserves to 58.9 percent of the world total.

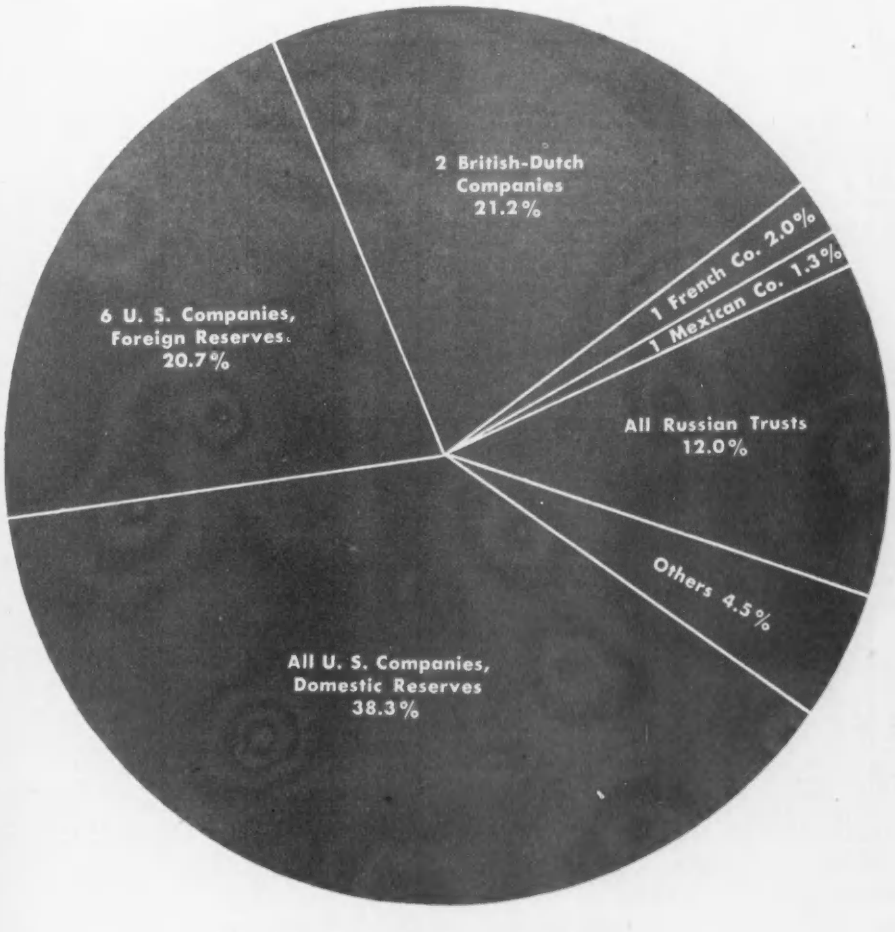
58.9 PERCENT OF World Reserves HELD BY U. S. FIRMS

THE situation of the U. S. with regard to crude reserves could not be considered satisfactory except for the fortunate fact that oils made from crude can be supplemented if necessary by oils from natural gas and coal.

On the present basis of getting liquid fuels almost wholly from crude, the nation is suffering a decline in both self-sufficiency and relative importance in the world picture, although the deteriorating U. S. position has been bolstered by development of large American holdings of crude reserves abroad.

In recent years, as for the whole history of the industry, the U. S. has accounted for more than 60 percent of the world production of crude, the nation's ratio in 1946 having been 62 percent. Yet the present available proved petroleum reserves within the U. S. constitute only about 38.3 percent of the proved world reserves, including U. S. natural gas liquids as well as crude petroleum. Including the foreign reserves held by U. S. oil companies, total American-controlled reserves constitute approximately 58.9 percent of the world total.

These percentages are based on estimated world reserves of 63,189,037,000 barrels, including 24,194,587,000 within the borders of the U. S. and 38,994,450,000 barrels in other countries. Besides owning virtually all the domestic reserves, U. S. companies hold approximately 13,051,450,000 barrels of the estimated reserves in foreign countries, which amount is 33.5 percent of the total foreign reserves and 20.7 percent of the world reserves. Together, the domestic U. S. reserves and the foreign reserves of U. S. companies amount to 37,246,037,000 barrels, or 58.9 percent of the world total. Of this total of American-held reserves, domestic reserves are 65 percent and foreign reserves are 35 percent. Those foreign reserves are held by half a dozen U. S. companies.


2 British-Dutch Companies 21.2%
1 French Co. 2.0%
1 Mexican Co. 1.3%
All Russian Trusts 12.0%
Others 4.5%
All U. S. Companies, Domestic Reserves 38.3%
6 U. S. Companies, Foreign Reserves 20.7%

WORLD RESERVES BY COMPANIES

British-Dutch Holdings

While these American companies control a third of the total of foreign crude reserves, almost the same amount, or another one-third of the total foreign reserves, is held by British-Dutch interests through two large companies, Anglo-Iranian Oil Company (here figured as the world's largest holder of reserves) and the Royal Dutch-Shell Group. These two large concerns, the first operating mainly in the Middle East and the latter worldwide, are here estimated as holding proved reserves of 13,377,400,000 barrels, not including Shell holdings in the U. S. through Shell Union Oil Corporation. This amount is 34.3 percent of the total reserves outside the U. S. and 21.2 percent of world reserves. British-Dutch nationals also hold limited reserves through some smaller companies, and by virtue of equaling Americans in ownership of foreign reserves, they are second to Americans in control of world reserves. The domestic and foreign reserves of all U. S. companies and the reserves of the Anglo-Iranian and Royal Dutch-Shell companies together represent 80.1 percent of world reserves.

By virtue of important interests in Middle East reserves, the French con-

cern, Compagnie Francaise des Petroles holds the equivalent of 2.0 percent of world reserves. Another large owner of reserves is Petroleos Mexicanos, Mexico's government company, with about 1.3 percent of world reserves. Adding the Compagnie Francaise and Petroleos Mexicanos reserves to those of Anglo-Iranian, Royal Dutch-Shell, and all U. S. companies, a total of 52,756,887,000 barrels is indicated, or 83.5 percent of world reserves. This is the greater part of world reserves outside Russia. Russian government trusts, holding an estimated 7,590,000,000 barrels of reserves, including those in Sakhalin, account for 12 percent of world reserves. This leaves only about 2,842,150,000 barrels of reserves, or 4.5 percent of the world total, unaccounted for, and this amount includes the reserves of all foreign companies or governments except the above listed British-Dutch, French, Mexican, and Russian companies or trusts.

The figure here used for world reserves is conservative, as it embodies lower figures than are sometimes used for Middle East reserves. Data are based on estimated actually *proved* reserves of 19,407,000,000 barrels in the Middle East and do not take into account the additional 9 to 10½ billion barrels of *indicated* reserves for fields that have been discovered but not yet fully explored. If this study had counted those strongly indicated but not definitely proved reserves in the Middle East, somewhat over one-half of the additional reserves would have been credited to American companies and nearly one-half to the British-Dutch interests.

As stated previously, Anglo-Iranian Oil Company is indicated by this study as the world's No. 1 company in ownership of crude reserves, by virtue of rich holdings in the Middle East. This company is owned 56 percent by the British government, 26 percent by the Burmah Oil Company of the Royal Dutch-Shell Group, and 18 percent by individuals. Its gross reserves are here estimated at 9,165,950,000 barrels, equivalent to 14.5 percent of world reserves and 23.5 percent of total reserves outside the U. S.

The Royal Dutch-Shell Group of affiliated companies, owned by British and Dutch interests, also is one of the leading companies in ownership of reserves. By including the group's 26 percent interest in Anglo-Iranian Oil Company and the U. S. affiliate, Shell Union Oil Company, the gross reserves that may be credited to the Royal Dutch-Shell organization total 7,369,597,000 barrels, equivalent to 11.7 percent of world reserves. These holdings make Royal Dutch-Shell the world's third largest owner of reserves.

Slightly outranked by Anglo-Iranian but rating above Royal Dutch-Shell is Standard Oil Company (N. J.), the world's No. 2 owner of reserves and the No. 1 owner among U. S. companies. Its gross reserves are here estimated at 8,489,225,000 barrels, including the share it is purchasing in Arabian American Oil Company and in Saudi Arabian reserves. The total includes only Standard's 72 percent interest in Humble Oil & Refining Company in the U. S. and its 93 percent interest in Creole Petro-

Estimated Domestic and Foreign Crude Oil Reserves of Some U. S. Companies at Beginning of 1947

Reserve figures are official (from annual report or prospectus) only if marked with asterisk (*); otherwise, estimated by WORLD OIL with aid of various sources, including Bache & Co. booklet, "The Oil Industry," published in July, 1947, and Merril, Lynch, Pierce, Fenner and Beane booklet, "Petroleum, 1946," published in late 1946.

(THOUSANDS OF BARRELS)

COMPANY	RESERVES			Domestic Production in 1946 (Net)	Annual Domestic Production as Percent of Domestic Reserves
	Domestic	Foreign	Total		
Amerada Pet. Corp.	385,000		385,000	18,091	4.7
Atlantic Ref. Co.	325,000		325,000	23,578	7.3
Barnsdall Oil Co.	210,000		210,000	9,701	4.6
Carter Oil Co. (wholly owned by S. O. Co. of New Jersey)	750,000		750,000	†21,000	2.8
Cities Service Co.	375,000		375,000	26,318	7.0
Continental Oil Co.	525,000		525,000	34,980	6.7
Creole Pet. Corp. (93% owned by S. O. Co. of New Jersey)		3,750,000	3,750,000		
Venezuela		3,750,000			
Gulf Oil Corp.	*1,000,000	2,945,000	3,945,000	75,124	7.5
Venezuela		*695,000			
Kuwait		2,250,000			
Humble O. & R. Co. (72% owned S. O. Co. of New Jersey	2,750,000		2,750,000	112,958	4.1
Lion Oil Co.	36,500		36,500	3,585	9.8
Mid-Continent Pet. Corp.	100,000		100,000	6,670	6.7
The Ohio Oil Co.	550,000		550,000	31,404	5.7
Phillips Pet. Co.	*1,179,641		*1,179,641	33,542	2.8
Plymouth Oil Co.	100,000		100,000	4,512	4.5
Pure Oil Co.	450,000		450,000	27,900	6.2
Richfield Oil Corp.	*220,000		*220,000	8,978	4.1
Seaboard Oil Co.	160,000		160,000	7,765	4.9
Shell Union Oil Corp.	775,000		775,000	65,224	8.4
Sinclair Oil Corp.	550,000	120,000	670,000	26,825	4.9
Venezuela		120,000			
Skelly Oil Co.	200,000		200,000	13,690	6.8
Socony-Vacuum Oil Co.	*1,149,000	1,326,725	2,475,725	60,590	5.3
Colombia & Venezuela		150,000			
Iraq (11.875% int. in Iraq pet. Co.)		582,350			
Qatar (11.875% int. in Iraq Pet. Co.)		59,375			
Saudi Arabia (10% int. in Arabian-American Oil Co.)		360,000			
East Indies		175,000			
South Penn Oil Co.	*57,095		*57,095	4,450	7.8
Standard Oil Co. of Calif.	1,350,000	1,244,000	2,594,000	79,461	5.9
Sumatra and New Guinea		25,000			
Bahrein Island (50% int. in Bahrein Pet. Co.)		139,000			

COMPANY	RESERVES			Domestic Production in 1946 (Net)	Annual Domestic Production as Percent of Domestic Reserves
	Domestic	Foreign	Total		
Saudi Arabia (30% int. in Arabian American Oil Co.)		1,080,000			
Standard Oil Co. (Indiana)	925,000		925,000	64,354	7.0
Standard Oil Co. (New Jersey)	2,730,000	5,759,225	8,489,225	102,330	3.7
U.S., 72% of Humble's 2,750 mln. reserve	1,980,000			81,330	4.1
U.S., Carter Oil Co., etc.	750,000			†21,000	2.8
Venezuela (93% of Creole Pet. Co.'s 3,750 mln reserve)		3,487,500			
Colombia, Peru, Argentina		250,000			
Saudi Arabia (30% int. in Arabian American Oil Co.)		1,080,000			
Iraq (11.875% int. in Iraq Pet. Co.)		582,350			
Qatar (11.875% int. in Iraq Pet. Co.		59,375			
East Indies		200,000			
Canada and Europe		100,000			
Standard Oil Co. (Ohio)	85,000		85,000	8,965	10.5
Sun Oil Co.	*650,000		*650,000	28,919	4.4
Sunray Oil Corp.	200,000		200,000	9,491	4.7
Superior Oil Co.	200,000		200,000	†16,000	8.0
Texas Co., The	1,600,000	1,394,000	2,994,000	85,127	5.3
Colombia & Venezuela		150,000			
Sumatra & New Guinea		25,000			
Bahrein Island (50% int. in Bahrein Pet. Co.)		139,000			
Saudi Arabai (30% int. in Arabian American Pet. Co)		1,080,000			
Texas Gulf Prod. Co.	*46,000		*46,000	2,878	6.3
Texas Pacific Coal & Oil Co.	65,000		65,000	†4,500	6.9
Tide Water Asso. Oil Co. (net)	*471,344		*471,344	32,623	6.9
Union Oil Co. of Calif. (net)	*410,100		*410,100	25,517	6.2
Total Above Companies	‡17,849,680	▫13,051,450	30,901,130	1,077,140	6.0
(Percent of Total for All Companies)	73.8	33.5	48.9	62.1	
Total Other Companies	6,344,907	25,943,000	32,287,907	656,284	10.3
(Percent of Total for All Companies)	26.2	66.5	51.1	37.9	
Total all Companies	◆24,194,587	38,994,450	63,189,037	1,733,424	7.2

* Official figure, obtained from 1946 annual report or prospectus.
† Approximate, exact data lacking.
‡ Omits Standard of N. J.'s interest in domestic reserves, held through subsidiaries ,Humble and Carter, as Humble and Carter are here included.
▫ Omits Standard of N. J.'s interest in Venezuelan reserves held through subsidiary, Creole Pet. Corp., as Creole is here included.
◆ U. S. reserves of 24,194,587,000 bbls. represent all liquid hydrocarbons and include 20,873,560,000 bbls. crude oil, 1,050,794,000 condensate, and 2,270,233,000 other natural gas liquids.

leum Corporation in Venezuela. These estimated total Standard of New Jersey reserves represent 13.4 percent of world reserves. This share in world reserves is closely in line with the company's participation in world oil operations, as in 1946 its affiliates accounted for 14.3 percent of world production and a similar proportion of refinery runs.

Other Leader

Fourth largest reserve owner in the world and second largest among U. S. companies is Gulf Oil Corporation, which has important holdings in Venezuela and Kuwait besides large U. S. reserves. Gulf's total reserves are here estimated at 3,945,000,000 barrels, or 6.2 percent of the world total.

The Texas Company is fifth in the world and third among U. S. companies in reserves, holding an estimated 2,994,000,000 barrels or 4.7 percent of world reserves, after giving effect to projected sale of a part of its equity in Saudi Arabian reserves. Although strictly a domestic operator, Humble Oil & Refining Company is the No. 1 owner of reserves within the U. S. and ranks sixth in the world, holding an estimated 2,750,000,000 barrels or 4.3 percent of world reserves. Standard Oil Company of California's estimated reserves of 2,594,000,000 barrels, after deducting the pending sale of a part of the company's share in Saudi Arabian reserves, are about one half in the U. S. and one half in the Middle East and constitute 4.1 percent of world reserves. Socony-Vacuum Oil Company's 2,475,725,000 barrels of estimated reserves, after purchase of an interest in Saudi Arabian reserves, also are roughly divided equally at home and abroad and represent 3.9 percent of total world reserves.

Phillips Petroleum Company and Standard Oil Company (Indiana) have around 1 billion barrels of reserves each, all being domestic, while companies with ½ to 1 billion barrels include Shell Union Oil Corporation, The Carter Oil Company, Sinclair Oil Corporation, Sun Oil Company, The Ohio Oil Company, and Continental Oil Company. Companies with reserves of 400 to 500 million barrels include Tide Water Associated Oil Company, The Pure Oil Company and Union Oil Company of California. Those with 300 to 400 million include Amerada Petroleum Corporation, Cities Service Company, and Atlantic Refining Company. In the 200 to 300 million barrel range are Barnsdall Oil Company, Skelly Oil Company, Sunray Oil Corporation, Superior Oil Company, and Richfield Oil Corporation. In the 100 to 200 million barrel class are Mid-Continent Petroleum Corporation, Plymouth Oil Company, and Seaboard Oil Company. Some of the larger companies with less than 100 million barrels include Standard Oil Company (Ohio), South Penn Oil Company, Texas Pacific Coal & Oil Company, Texas Gulf Producing Company, Lion Oil Company.

Reference to one of the tables herewith shows that of the total United States domestic reserves of crude and other petroleum liquids, amounting to 24,194,587,000 barrels, 73.8 percent is held by 31 companies or affiliated groups. This situation reflects an exceptionally decentralized and competitive industry and contrasts with some other leading U. S. industries where only a few companies account for the bulk of the business. The other 26.2 percent of reserves is in the hands of many smaller producers.

For the industry as a whole, U. S. reserves were produced in 1946 at the rate of 7.2 percent annually. This was a somewhat higher rate than the average for the past, when withdrawals sometimes have been only 5 or 6 percent annually. It also was a much higher rate than in most of the more important foreign producing countries. The 31 larger companies in the aggregate produced their reserves in 1946 at the rate of 6.0 percent annually, or at less than the national average rate, reflecting pinching back of flowing wells, although half a dozen among the 31 were above the national average, while nearly a dozen were producing only 4 to 5 percent of their reserves annually. The smaller companies in the aggregate produced their reserves at the rate of 10.3 percent annually, considerably above the national average, in reflection of the operation of many settled-production properties, although many smaller companies have flush production and show low rates of producing their reserves.

Estimated Petroleum Reserves Held by Several Outstanding Foreign Companies and Comparison with Reserves of All U. S. Companies

(Data estimated by WORLD OIL, with aid of various sources.)

(THOUSANDS OF BARRELS)

ALL COMPANIES	
World Reserves (incl. U. S. natural gas liquids)	63,189,037
U. S. Reserves (incl. natural gas liquids)	24,194,587
(Percent of world)	38.3
Foreign Reserves	38,994,450
(Percent of world)	61.7
U. S. COMPANIES	
(For individual company data on 31 U. S. companies see separate table)	
All U. S. Companies' Total Reserve (incl. Shell Union)	37,246,037
(Percent of world)	58.9
U. S. Companies' Domestic Reserves	24,194,587
(Percent of U. S. Co. total)	65.0
(Percent of world total)	38.3
U. S. Companies' Foreign Reserves	13,051,450
(Percent of U. S. Co. total)	35.0
(Percent of world total)	20.7
(Percent of foreign total)	33.5
BRITISH-DUTCH COMPANIES	
Anglo-Iranian Oil Co. (British Govt. 56%, Burmah Oil Co. of Royal Dutch-Shell group 26%, individuals 18%), Total Reserves	9,165,950
(Percent of world Reserves)	14.5
(Percent of Reserves outside U. S.)	23.5
England	7,500
Iran	5,625,000
Iraq (23.75% int. in Iraq. Pet. Co.)	1,164,700
Qatar (23.75% int. in Iraq Pet. Co.)	118,750
Kuwait (50% int. with Gulf Oil 50%)	2,250,000
Royal Dutch-Shell Group excl. Shell Union of U. S. and excl. interest in Anglo-Iranian, total reserves	4,211,450
(Percent of world Reserves)	6.7
(Percent of Reserves outside U. S.)	10.8
Iraq (23.75% int. in Iraq Pet. Co.)	1,164,700
Qatar (23.75% int. in Iraq Pet. Co.)	118,750
Egypt	138,000
Austria	20,000
Roumania	150,000
Burma	100,000
India	25,000
British Borneo	200,000
Netherlands India	525,000
Canada	75,000
Argentina	55,000
Colombia	75,000
Ecuador	20,000
Peru	45,000
Venezuela	1,500,000
Royal Dutch-Shell Group, incl. U. S. reserves through Shell Union	4,986,450
U. S. reserves (Shell Union Oil Co. reserves)	775,000
Royal Dutch-Shell Group incl. Shell Union in U. S. and incl. 26% interest in Anglo-Iranian Oil Co.	7,369,597
(Percent of world Reserves)	11.7
The 26% int. in Anglo-Iranian Oil Co.	2,383,147
Royal Dutch-Shell Group excl. Shell Union in U. S. but incl. 26% interest in Anglo-Iranian Oil Co.	6,594,597
(Percent of world Reserves)	10.4
(Percent of Reserves outside U. S.)	16.9
FRENCH COMPANY	
Compagnie Franciase des Petroles	1,283,450
(Percent of world Reserves)	2.0
(Percent of Reserves outside U. S.)	3.3
Iraq (23.75% int. in Iraq Pet. Co.)	1,164,700
Qatar (23.75% int. in Iraq Pet. Co.)	118,750
MEXICAN COMPANY	
Petroleos Mexicanos (Govt. company)	850,000
(Percent of world Reserves)	1.3
(Percent of Reserves outside U. S.)	2.2
TOTAL OF ABOVE COMPANIES	
Total all U. S. companies, Anglo-Iranian, Royal Dutch-Shell, Compagnie Francaise, and Petroleos Mexicanos	52,756,887
(Percent of world Reserves)	83.5
RUSSIAN TRUSTS	
All Russian govt. trusts, incl. Sakhalin	7,590,000
(Percent of world Reserves)	12.0
(Percent of Reserves outside U. S.)	19.5
OTHER FOREIGN COMPANIES	
All foreign companies except the above listed British-Dutch, French, Mexican, and Russian companies, total Reserves	2,842,150
(Percent of world Reserves)	4.5
(Percent of Reserves outside U. S.)	7.3

Potential Demand FOR OILS IN 1948

SINCE potential demand for petroleum products has increased more sharply than it has been possible to expand facilities for supplying the oils under existing handicaps and shortages, it is indicated that the industry will continue to operate virtually at capacity in 1948, achieving meanwhile some increase in capacity, without being able to meet fully the requirements of its customers.

Even in 1947 this abnormal situation has existed, in which it has not been possible to satisfy all demand fully. Deficiency arose as early as June, 1947, when refiners of the Midwest were obliged to begin allocating gasoline to their dealers, in proportion to former sales, while the dealers in turn had to allocate supplies among their customers. While Midwestern allocations are still necessary, a similar division of supplies of gasoline and other products among dealers and consumers lately has been initiated in the New England and Middle Atlantic states.

Heretofore, it has been the consensus in the industry that shortages could be confined to local and temporary situations, such as those which have prevailed in the Midwest. But the present East Coast shortage was not foreseen, and it now appears that scarcity of oils may last longer and be more serious than was formerly anticipated. Making it difficult for the industry to establish a balance of supply with demand is a number of factors, including shortages of materials for expansion of facilities on the one hand and the constantly increasing demand on the other. The longer it takes to provide extra capacity, the more extra capacity is needed.

European Aid Drain

To further complicate the problem of balancing supply with demand, the aid to Europe plan now confronts the industry, foreshadowing a likely increase in shipments of U. S. and other oils to Europe and a probable stimulation of exports of American-made oil industry equipment to Europe and to the Middle East and the Caribbean area, which will be the principal sources of oil for Europe.

When all factors are considered, it is indicated that any forecast of the operations of the oil industry of the U. S. in 1948 must be essentially an estimate of supplies that will be available rather than the usual forecast of the probable demand for petroleum products. This is something quite unusual in projecting oil industry operations into the future, having become necessary only since shortages began to develop in 1947.

It is upon this extraordinary basis of estimating probable available supply that the Bureau of Mines, U. S. Department

Forecast of United States Supply and Demand, All Oils, 1948, and Revised Estimate for 1947

Source: U. S. Bureau of Mines Monthly Petroleum Forecast, Nov., 1947

(THOUSANDS OF BARRELS)

ITEM	1946 (Actual)	1947 (Partly Estimated)	Percent Change '46-'47	1948 (Forecast)	Percent Change '47-'48
PRODUCTION					
All Oils	1,850,700	1,980,300	+ 7.0	2,075,300	+ 4.8
(Daily Average)	5,070	5,425	+ 7.0	5,670	+ 4.8
Crude Oil	1,733,400	1,849,900	+ 6.7	1,936,200	+ 4.7
(Daily Average)	4,749	5,068	+ 6.7	5,290	+ 4.7
Other Oils	117,300	130,400	+11.2	139,100	+ 6.7
(Daily Average)	321	357	+11.2	380	+ 6.7
IMPORTS					
All Oils	135,000	157,000	+16.3	166,800	+ 6.2
(Daily Average)	370	430	+16.3	456	+ 6.2
Crude Oil	86,100	97,700	+13.5	100,800	+ 3.2
(Daily Average)	236	268	+13.5	275	+ 3.2
Other Oils	48,900	59,300	+21.3	66,000	+11.3
(Daily Average)	134	162	+21.3	180	+11.3
NEW SUPPLY					
All Oils	1,985,700	2,137,300	+ 7.6	2,242,100	+ 4.9
(Daily Average)	5,440	5,856	+ 7.6	6,126	+ 4.9
STOCKS CHANGE					
All Oils	+43,500	+4,800	—89.0	+ 8,100	+68.8
(Daily Average)	+119	+14	—89.0	+ 22	+68.8
Crude Oil	+6,900	+4,400	—36.2	+ 500	—88.6
(Daily Average)	+19	+12	—36.2	+ 1	—88.6
Other Oils	+36,600	+400	—98.9	+ 7,600	+18.0
(Daily Average)	+100	+1	—98.9	+ 21	+18.0
DEMAND					
All Oils, Total Demand	1,942,200	2,132,500	+ 9.8	2,234,000	+ 4.8
(Daily Average)	5,321	5,842	+ 9.8	6,104	+ 4.8
Domestic Demand	1,791,000	1,969,500	+10.0	2,085,000	+ 5.9
(Daily Average)	4,907	5,396	+10.0	5,697	+ 5.9
Exports	151,200	163,000	+ 7.8	149,000	— 8.6
(Daily Average)	414	447	+ 7.8	407	— 8.6
Crude Oil Exports	40,700	45,500	+11.8	50,000	+ 9.9
(Daily Average)	111	125	+11.8	137	+ 9.9
Refined Oil Exports	110,500	117,500	+ 6.3	99,000	—15.7
(Daily Average)	303	322	+ 6.3	270	—15.7

ITEM	1946 (Actual)	1947 (Partly Estimated)	Percent Change '46-'47	1948 (Forecast)	Percent Change '47-'48
Motor Fuel, Total Demand	780,200	835,400	+ 7.1	876,000	+ 4.9
(Daily Average)	2,138	2,289	+ 7.1	2,393	+ 4.9
Domestic Demand	734,800	790,000	+ 7.5	840,000	+ 6.3
(Daily Average)	2,013	2,164	+ 7.5	2,295	+ 6.3
Exports	45,400	45,400	.....	36,000	—20.7
(Daily Average)	125	125	.....	98	—20.7
Residual Fuel, Total Demand	486,600	524,000	+ 7.7	529,000	+ 1.0
(Daily Average)	1,333	1,436	+ 7.7	1,445	+ 1.0
Domestic Demand	477,100	513,000	+ 7.5	517,000	+ 0.8
(Daily Average)	1,307	1,405	+ 7.5	1,413	+ 0.8
Exports	9,500	11,000	+15.8	12,000	+ 9.1
(Daily Average)	26	30	+15.8	33	+ 9.1
Distillate Fuel, Total Demand	272,300	320,200	+17.6	346,000	+ 8.1
(Daily Average)	746	877	+17.6	945	+ 8.1
Domestic Demand	243,000	290,000	+19.3	328,000	+13.1
(Daily Average)	666	795	+19.3	896	+13.1
Exports	29,300	30,200	+ 3.1	18,000	—40.4
(Daily Average)	80	83	+ 3.1	49	—40.4
Kerosine, Total Demand	97,700	108,400	+11.0	118,000	+ 8.9
(Daily Average)	268	297	+11.0	322	+ 8.9
Domestic Demand	89,200	101,000	+13.2	110,000	+ 8.9
(Daily Average)	245	277	+13.2	301	+ 8.9
Exports	8,500	7,400	—12.9	8,000	+ 8.1
(Daily Average)	23	20	—12.9	22	+ 8.1
All Other Oils, Total Demand	305,400	344,500	+12.8	365,000	+ 6.0
(Daily Average)	837	944	+12.8	997	+ 6.0
Domestic Demand	246,900	275,500	+11.6	290,000	+ 5.3
(Daily Average)	677	755	+11.6	792	+ 5.3
Exports	58,500	69,000	+17.9	75,000	+ 8.7
(Daily Average)	160	189	+17.9	205	+ 8.7
CRUDE NEEDED					
Runs to Stills	1,730,100	1,842,155	+ 6.5	1,926,990	+ 4.6
(Daily Average)	4,740	5,047	+ 6.5	5,265	+ 4.6
Demand for Domestic Crude	1,727,545	1,845,805	+ 6.8	1,935,774	+ 4.9
(Daily Average)	4,733	5,057	+ 6.8	5,289	+ 4.9

TO EXCEED REFINING CAPACITY

of Interior, has offered its forecast of oil industry operations in 1948. In this forecast, the bureau estimates that the total demand for all oils to be supplied by the industry in 1948 will average 6,104,000 barrels daily, an increase of 262,000 barrels per day or 4.8 percent over the 5,842,000 barrels daily indicated for 1947.

In the latter half of 1947, the fulfillment of demand for petroleum products came to be largely a matter of maximum refining capacity, and similarly, in 1948, the amount of demand to be met will be determined mainly by the volumes that can be put through the available refinery facilities. Thus the indicated prospective increase in total demand for oils in 1948 is essentially the same as the indicated possible increase in refinery runs, which the Bureau of Mines estimates at 5,265,000 barrels daily in 1948, an increase of 218,000 barrels per day or 4.6 percent over the estimated average runs of 5,047,000 barrels daily in 1947. An increase for 1948 over 1947 will have to be achieved, if accomplished, in spite of higher than normal operating rates at refineries in 1947. But new refinery capacity is entering the picture to make an increase possible of achievement.

In its forecast, the Bureau of Mines assumed a decrease in exports to 407,000 barrels daily in 1948 from an indicated 447,000 daily in 1947. On that assumption, it was calculated that the domestic demand which could be fulfilled in 1948 would average 5,697,000 barrels daily, an increase of 301,000 barrels per day or 5.9 percent over the 5,396,000 daily indicated for 1947. Lower exports would leave more for domestic use, it was pointed out, or higher exports would leave less.

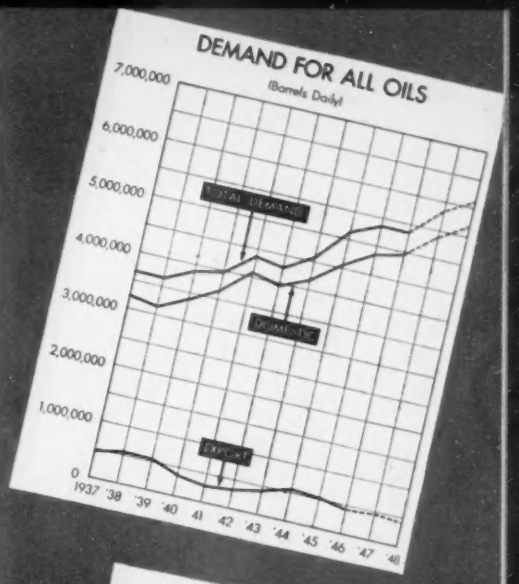
It is noteworthy that the forecast for 1948 contemplates a change for the U. S. from the traditional role of net exporter of oil to that of net importer, a change heretofore reflected in monthly but not annual statistics. Against the estimated 407,000 barrels per day of exports in 1948, the U. S. would import 456,000 barrels daily, according to the forecast, a net importation of 49,000 barrels per day. In 1947 U. S. exports of 447,000 barrels daily will exceed imports of 430,000 daily by 17,000 barrels, it is indicated.

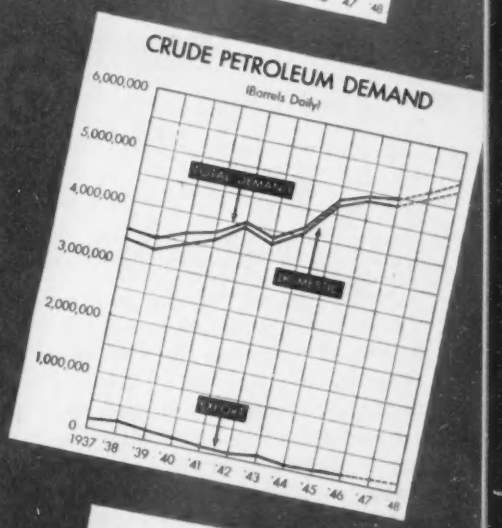
In discussing its forecast for 1948, which is embodied in its Monthly Petroleum Forecast for November, 1947, the Bureau of Mines explained that the forecast was, of necessity, "based on the probable supply of oil products as determined by available refinery capacity and the limits of existing transportation facilities to move crude oil to refineries and to distribute products.

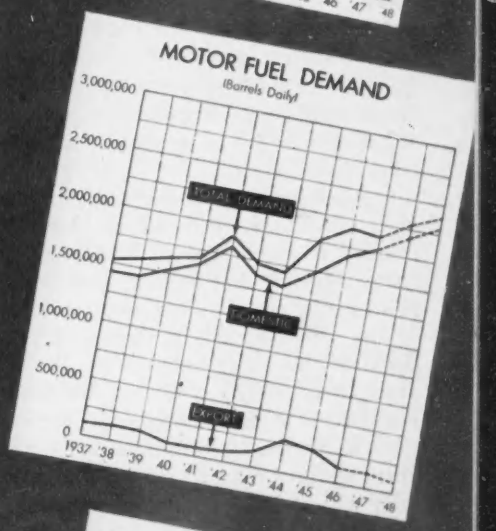
"The primary controlling factors," stated the bureau, "is the estimate of crude runs to stills, and it is believed that this estimate is reasonably optimistic after allowing for necessary refinery shutdowns for repairs or emergencies.

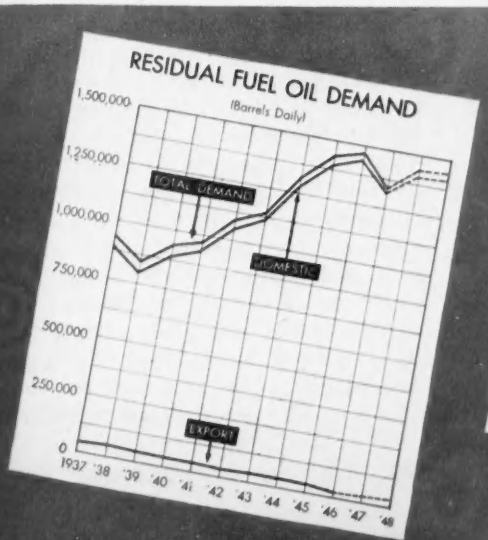
"Potential demand for oil products should be substantially greater than the forecast of demand that might be supplied under existing conditions," the agency pointed out.

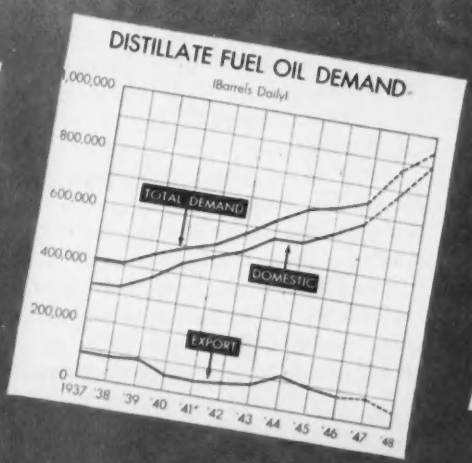
"Imports can be projected only on the basis of present trends and policies," the explanation continued. "Imports of refined products (chiefly residual fuel oil) supplement the limited output of our own refineries."

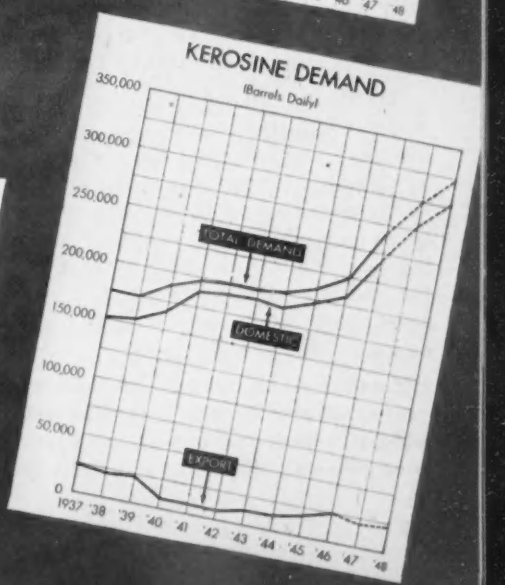


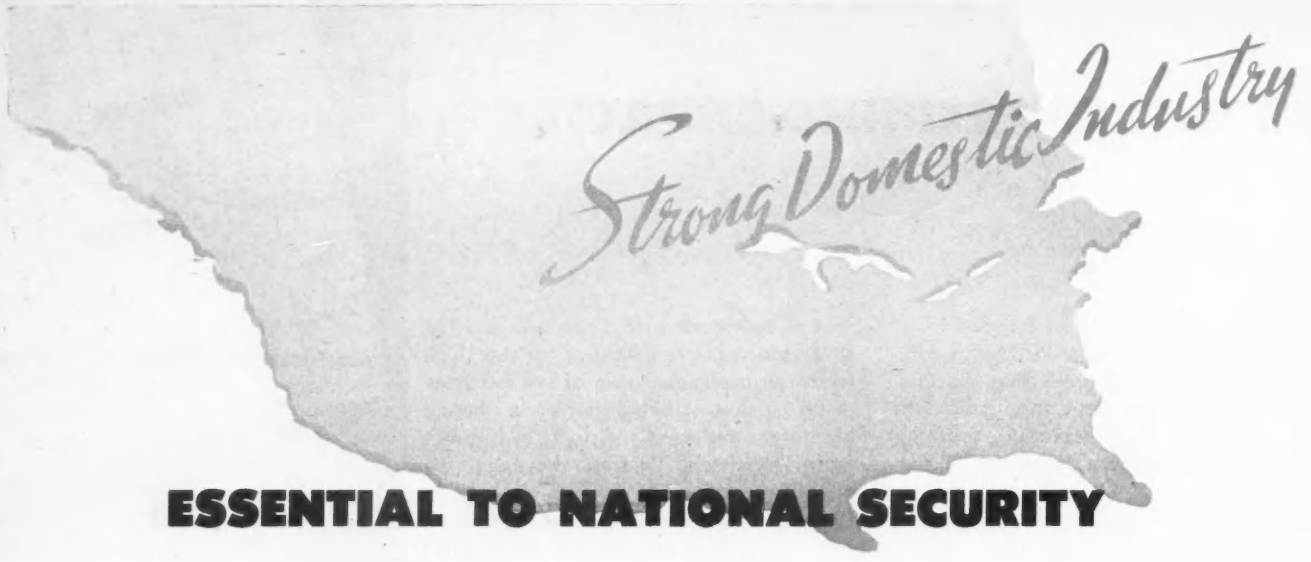












ESSENTIAL TO NATIONAL SECURITY

By WARREN L. BAKER
Editor

BECAUSE of wartime and postwar shortages there has arisen a wide public interest in the nation's natural resources. Inherent in this situation is the danger of public endorsement of unsound or disastrous national policies with respect to the use and development of U. S. mineral resources—policies that would restrict and stifle the natural resource industries and fail to assure adequate supplies.

In the case of the petroleum industry, current difficulties in providing adequate supply can and will be cleared up satisfactorily in a reasonably short time, as the industry is attacking this problem quite effectively. Nevertheless, some politically powerful groups and some departments of the federal government point to the present situation as evidence or the necessity of turning to foreign countries for large volumes of oil. This proposal is offered under the fine-sounding theory of conserving our own supplies until needed for national security purposes in the future. Due to unfamiliarity with the operations of the industry, many will sincerely accept this as the best policy for the welfare of the nation.

Experience shows that the idea of using the natural resources of other countries and stopping the use and development of your own is unsound and dangerous. There is not a single example in history of national hoarding benefiting any country. Instead of protecting the security of a nation, such a policy jeopardizes the very safety of the country.

Suppose we had listened to "have not" propagandists in the past, and had adopted a policy of buying our supplies from abroad. Our mines and wells soon would have become idle. These industries with their skilled labor and technologists would surely have disappeared. Because the production of minerals, especially liquids like petroleum, cannot be turned off and on at will but involves many time-consuming development risks, we would have been without oil when war planes appeared over Pearl Harbor and we would not have had the trained men, facilities, or time to have developed a new supply. Stoppage of oil shipments from nearby Venezuela by German submarines during the early stages of this war demonstrated how dangerous it will be ever to let our national security depend upon foreign oil sources. This is a lesson that must never be forgotten.

Rebuilding Vital

It is essential to the national security that the domestic petroleum producing ability be rebuilt to prewar status. Drilling must be accelerated to meet the increased requirements and also to rebuild the all-important reserves to the point where they are sufficient to supply any emergency demand that may be encountered.

It appears paradoxical, but experience shows that the best way to have an adequate supply of minerals is not to leave them in the ground—but to use them!

Fortunately, the U. S. did not adopt a policy of depending upon foreign supplies following World War I, when similar proposals were made. Instead, we continued under our system of free enterprise, and our mining industries remained healthy and alive. Consequently, there occurred through the years a steady improvement in finding, producing and refining methods. These enabled this country to constantly discover, produce and refine larger and larger quantities of minerals at cheaper and cheaper costs, although frequently dependence was upon poorer quality sources of supply than used previously. History of our mineral industry proves that the best conserving and multiplying agent is the progress that comes from healthy, competitive businesses.

Take the oil industry, for example. Today, improved prospecting techniques make it possible to locate favorable structures that would remain unknown if we were still dependent upon the methods in use 25 years ago. This has resulted in oil being produced in areas and at depths that were undreamed of at the end of World War I. Advancements in drilling enable us to reach petroleum lying three times as far below the surface as was possible in 1920. This has made huge new quantities of petroleum available for use. We produce 70 to 80 percent of the oil contained in most reservoirs today, which is twice the recovery of 25 years ago. We now operate fields that a few years ago would have been abandoned because of inefficient methods then in use. We have even discovered how to go into depleted fields and make them give up millions of barrels of additional oil. Many millions have been saved through improved refinery techniques. Scientists have found how to make synthetic rubber, plastics, and many other items from oil and gas.

Were it not for the progress in discovery, drilling, producing and refining methods, the U. S. would have exhausted its available supply of petroleum years

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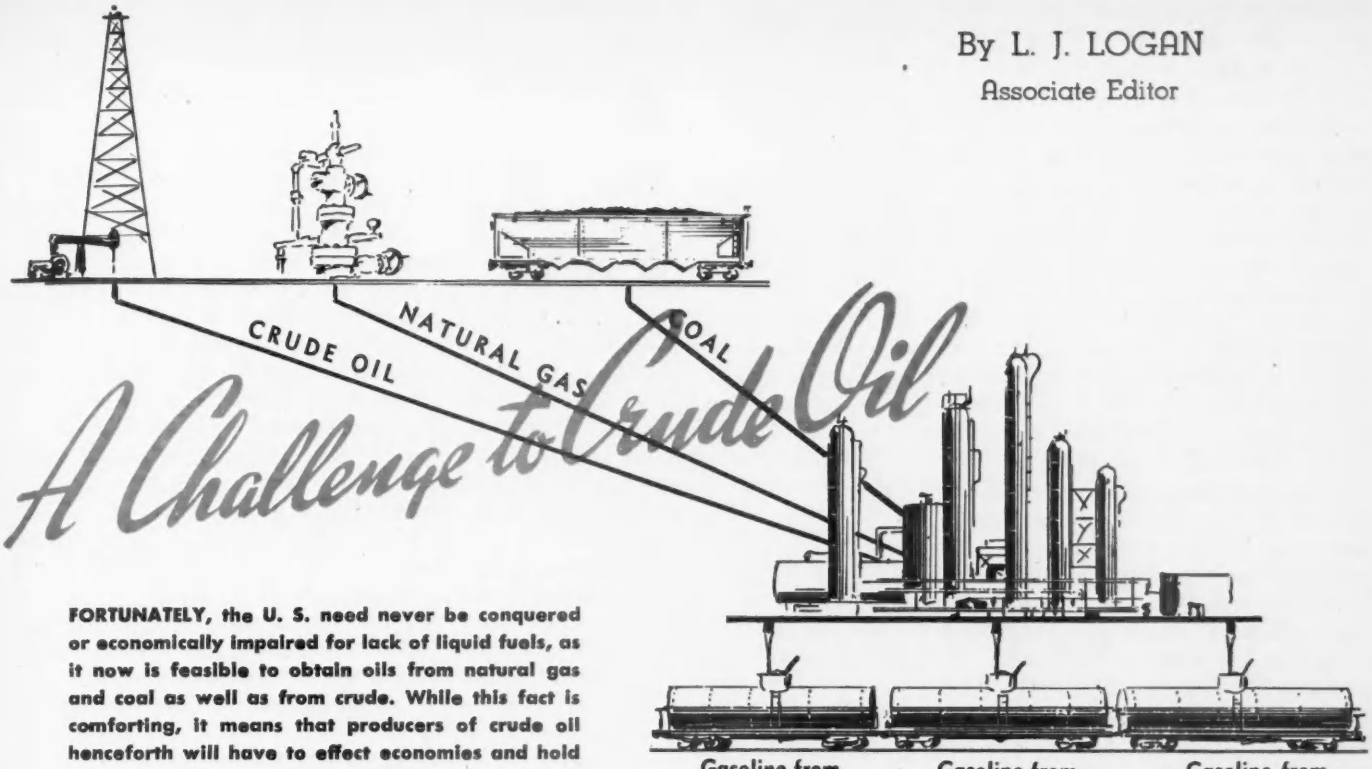
By L. J. LOGAN
Associate Editor

A Challenge to Crude Oil



FORTUNATELY, the U. S. need never be conquered or economically impaired for lack of liquid fuels, as it now is feasible to obtain oils from natural gas and coal as well as from crude. While this fact is comforting, it means that producers of crude oil henceforth will have to effect economies and hold down costs to meet the impending competition of oils from natural gas and coal.

JUST as the U. S. through wartime necessity made itself virtually independent of natural rubber by manufacturing a substitute "raw rubber" from materials at hand, so the country could if necessary make itself independent of natural crude petroleum within a few years by synthetically making substitute "petroleum" from any of several available materials.

It is not only scientifically possible to substitute natural gas or coal for crude oil in making liquid fuels, but natural gas already is actively competitive with crude as a raw material for the petroleum industry, while coal quite possibly may become a commercially employed source of liquid fuels within five to ten years, being already in the pilot plant stage of such utilization.

Several commercial scale plants for obtaining gasoline and other liquid fuels from dry natural gas already are under construction or planned, including that at Brownsville, Texas, and one scheduled for the Hugoton gas field, Kansas. Proved U. S. reserves of natural gas are equivalent in heat content to those of crude oil.

Also under construction, near Pittsburgh, is a pilot plant for converting coal into gas, with the ultimate aim of then converting such "synthesis gas" into gasoline and other liquid fuels by the same process as that to be used in the Texas and Kansas natural gas-to-gasoline plants. U. S. reserves of coal are so great as to make the proved reserves of crude oil and natural gas appear almost insignificant by comparison. Coal represents 98.8 percent of the country's mineral fuel energy reserves, excluding fissionable materials; oil shale constitutes 0.8 percent; petroleum 0.2 percent; and natural gas 0.2 percent.

While oil shale reserves are relatively large, and while oil is being obtained from shale in some petroleum-deficient countries, the production of oil from shale so far has proved difficult and costly and it will be resorted to in the U. S. only if much better methods are developed.

Self-Sufficiency Assured

The present potential independence of the U. S. from natural crude petroleum, which heretofore was a vital essential, is a fact of tremendous significance to the nation and all its citizens, because it gives assurance that the U. S. A. need never be conquered or commercially exploited for lack of liquid fuels. While crude petroleum reserves of the U. S. and of the rest of the world are of continuing importance, they are not a matter of life or death for the nation or even of continued health and prosperity. If our crude reserves look too small and difficult to maintain in the face of enormous present day and prospective requirements, and if we refuse to lean too heavily upon foreign crude reserves, it is necessary only to reduce our reliance upon crude of any origin and to begin depending at least partially upon coal. The problem of reserves would thereby be solved rather permanently, as U. S. coal reserves are equivalent to the nation's fuel needs for more than 1000 years.

Instead of bothering to drill for crude at excessive depths, in remote and inaccessible places, upon the storm-swept open sea of the Continental Shelf, or under other prohibitively difficult conditions, the petroleum industry fortunately has an alternative. If the less accessible potential crude reserves are too difficult or costly to develop, the industry can leave them undeveloped and begin using as its raw material, in larger and larger proportion, first natural gas and eventually coal.

So important and so promising is the future role of synthetically produced liquid fuels that encouragement of the development of such fuels is almost unanimously agreed upon as a vital point in the national policy on petroleum. Both large and small oil companies as well as key government agencies and officials consider it wise to develop synthetic oils to supplement natural petroleum as promptly as possible, although many Americans very much dislike the thought of encouraging or even permitting large-scale imports of crude to supplement domestic, believing that a strong and self-

sufficient domestic fuels industry is a vital necessity in national defense.

So thoroughly is the importance of synthetic oils accepted within the petroleum industry itself that some of the larger oil companies, which are spending millions of dollars annually in research, are devoting around one third of all such expenditures to research in synthetic fuels. While they thereby recognize the crude supply as an increasingly important problem, they also thereby assert their determination not to let the problem defeat them—the determination to keep on meeting any demand for liquid fuels that may develop, by going to substitute raw materials if necessary.

While the development of synthetic liquid fuels serves the interest of the nation and the industry by affording the possibility of reducing dependence on crude petroleum, this development also has a secondary value in that it will force a maximum of progressiveness and efficiency in the continuing production of natural petroleum. By threatening to supplant oil from natural petroleum, the new oil from natural gas and oil from coal will make it imperative for the producers of natural petroleum and their engineers and scientists to work out the most efficient and cheapest methods of drilling and production. For the engineers of crude producing companies, synthetic fuels issue a challenge that can be met only by further advances in drilling and producing techniques. As the synthetic processes are further developed upon commercial basis, they may be expected to make the synthetic fuels available at lower costs, while it will be difficult to prevent the costs of oils from natural petroleum from further increasing, in view of the need for drilling deeper and other manifestations of greater difficulty in proving up new crude reserves. In prospective competition between producers of synthetic and natural oils, the crude oil producers thus are at a disadvantage that can be offset only by improvements in existing methods and practices.

Competition Is Here

While competition between synthetic oils and natural petroleum is only in its initial stages, the synthetic oils from dry natural gas by the Fischer-Tropsch process must be recognized as already actively competitive with oils from crude petroleum. The first two projected plants, in Texas and Kansas, will be full-blown commercial "gas refineries," costing in excess of $15 million each and producing from natural gas about 7500 barrels per day of high octane gasoline, alcohols, diesel oil, and other products, with gasoline representing about 80 percent of the total and distillate fuel oil 13 percent. The plants will commercially apply the same methods used for three years by Standard Oil Company (N. J.) in a pilot plant at Baton Rouge, La., making 20 to 30 barrels per day of liquid fuels.

When the Texas plant was announced about two years ago (prior to decontrol of prices) the owners estimated that gasoline would be produced at a cost of about 5½ cents a gallon, about the same as the cost then involved for gasoline refined from crude. While the cost perhaps should be figured higher now, because of increased plant construction costs, it is possible that capital costs may be held down or even reduced as experience in operating the plants points the way to improvements in plant design. Natural gas as the raw material is only about 20 percent of the cost of the gasoline produced, as against 50 percent for capital charges, indicating that gas prices would have to increase substantially before appreciably raising the cost of gasoline from gas. Even if the total cost of gasoline from natural gas is estimated to have increased 25 percent above the 5½ cents of two years ago, in line with the increase meanwhile in construction costs, then a present cost of only 7 cents a gallon is indicated.

In contrast, crude prices in the past two years increased 90 cents a barrel or nearly 2¼ cents a gallon, adding that much to the crude oil refiner's cost of raw material alone, in addition to other increases in his costs. The average price of crude in the U. S. having reached $2.13 per barrel, unrefined crude itself now costs 5 cents a gallon at the well, before transportation to the refinery. Because of higher crude and operating costs, Mid-Continent refiners of gasoline from crude have had to increase their quotations to a range of 8 to 10¼ cents a gallon (November 15, 1947), depending on octane rating. Apparently, the cost of gasoline from crude oil now appreciably exceeds the cost of gasoline from natural gas, making gas-to-gasoline plants quite attractive.

The initial 15,000 barrels per day of synthetic oil production from natural gas is expected before 1950, and such production has been estimated by a qualified oil company economist at 200,000 barrels daily by 1956. On this basis, from the standpoint of meeting demand for gasoline, the future "gas refineries," using natural gas as the raw material, would wipe out demand for crude oil by 30,000 barrels daily in 1950 and by 400,000 barrels daily in 1956, allowing for a 40 percent gasoline yield from crude as at present. In the "gas refinery" the dry natural gas is first broken down by partial burning into carbon monoxide gas and hydrogen gas. Those gases then are fed into a synthesis reactor, where they combine, in the presence of a finely powdered catalyst, to form the liquid fuels.

In view of the projected production of oils from natural gas, it may be stated as a general rule that henceforth it will be profitable to drill a contemplated oil well only if oils made from the crude oil it yields involve overall costs no greater than those of oils derived from natural gas. It remains to be seen, for example, whether or not cheap and plentiful natural gas as a source of oils will discourage or make impractical any efforts to produce natural oils at depths of 15,000 or 20,000 feet or from structures beneath the open ocean along the Continental Shelf.

Fischer-Tropsch Variation

Oil from coal in the U. S. will be merely a variation of the Fischer-Tropsch process, using coal instead of natural gas as the source for the synthetic oils. Instead of partially burning natural gas into carbon monoxide and hydrogen and then catalytically converting those gases into liquid fuels, the oil-from-coal refinery will mine and finely crush large tonnage of coal and convert the fine coal, with aid of steam and oxygen or air, into carbon monoxide and hydrogen gases, which then are converted catalytically into the liquid fuels. To get the carbon monoxide and hydrogen from coal instead of natural gas obviously is the harder way because of requiring the mining and crushing operations for several thousands of tons of coal per day in the case of a large commercial plant instead of connecting up with a natural gas pipe line.

Although oil from coal is only in the pilot plant stage and not yet competitive with oil from crude petroleum, the coal and oil interests which are now actively developing the process envisage the first commercial-scale plant production of oil from coal by 1950-1951. The actively competitive stage for oil from coal may be no more than five or ten years away, although it has not been definitely set down on the calendar by some forecasters until 1970.

The pilot plant near Pittsburgh for gasifying coal, now under construction, will cost about $300,000, process 50 tons of coal daily, and produce about 2,400,000 cubic feet of synthesis gas per day. That synthesis gas could be then converted into about 120 barrels per day of synthetic gasoline, but that extra step will not be taken at the pilot plant, for it would be essentially the same as in the conversion of natural gas into gasoline, while a pilot plant at Linden, N. J., already is experimentally producing 15

gallons per day of liquid fuels from synthesis gas.

"Coal Refinery"

After the pilot plant near Pittsburgh shows the way to gasify coal, there will be built the first commercial-scale "coal refinery." It is envisaged as a mammoth plant, costing perhaps $120 million and doing a complete job of supplying gaseous or liquid fuels, taking in coal from the mouth of the mine and turning out either high-value gas or liquid fuels for convenient marketing in the adjacent region. While this synthesis gas will not be low enough in cost to compete with natural gas from the Southwest, it is expected to command premium prices for meeting emergency or extraordinary winter demands, and at other seasons the bulk of the output will be converted into liquid fuels.

So far, oil from natural petroleum has some competitive advantage over oil from coal. It has been estimated by one oil company research man that crude oil could rise another $1 per barrel in price before running into serious competition from coal as the raw material for liquid fuels. Another major oil company has estimated that motor fuel could be produced from coal for between 7 and 10 cents per gallon, while still another authoritative study put the cost at 6½ cents a gallon, or at a level definitely competitive with motor fuel produced from crude oil.

Any competitive advantage that crude oil now holds over coal is not great enough to justify complacency among crude oil producers or petroleum engineers as to the present methods of drilling and the prevailing methods of operating oil fields. The costs of producing oil from coal are virtually certain to come down as the methods now contemplated are perfected or as new and better methods are developed. Offering the possibility of great savings in making oils from coal, for example, is the underground gasification of coal, which has been tried experimentally with some success and which would cut out the heavy costs of mining and crushing the coal. Meanwhile, as brought out previously, the costs of producing oils from natural petroleum threaten to further increase rather than to come down because it has become necessary to drill deeper, drill in less accessible places, resort to secondary recovery, and assume other extra costs in the increasingly difficult effort to find and develop as much crude oil as the nation is consuming, with usage at unprecedented proportions and constantly expanding.

Leonard F. McCollum

Dan J. Moran

Leonard F. McCollum Becomes President of Continental

Leonard F. McCollum, coordinator of producing activities for Standard Oil Company (N.J.), became president of Continental Oil Company December 1, succeeding Dan J. Moran, who will continue with the firm in a consulting capacity.

John W. Brice

McCollum is succeeded by John W. Brice, for the last 20 years engaged in exploration and producing activities for Jersey Standard and affiliates.

McCollum was born in 1902 at Bradford, Tenn., and received his early education at Fordtran and Cuero, Texas. After winning a degree in geology from the University of Texas in 1925, he joined Humble Oil & Refining Company as geologist at Amarillo and San Antonio. In 1934 he went with The Carter Oil Company as chief geologist and manager of exploration. He became executive vice president in 1938 and president in 1941. He resigned from Carter in 1943 to become vice president and director with Standard.

Moran, born at Cygnet, Ohio, in 1888, has been connected with the oil industry since 1905, when he joined Buckeye Pipe Line Company. He won a degree from the University of Dayton in 1907, did graduate work at the Case School of Applied Science, then joined The Texas Company. In 1921 he was made vice president and general manager for the company in Mexico and built two refineries and extensive pipe line facilities. Returning to the U. S., he became general manager of the producing department and later was elected a vice president, director and member of the executive committee.

In 1928 he became president of Marland Oil Company, which under his direction was reorganized.

Brice was born at Miami, Texas, in 1903, received a degree in geology from the University of Texas in 1927, and the same year joined Humble as a geologist. He served with Jersey affiliates in Venezuela before moving to Tulsa with Carter, where he became executive vice president and a member of the board of directors. In 1945 he went to New York as assistant coordinator of producing activities for Jersey Standard.

Strong Domestic Industry

■ CONTINUED FROM PAGE 64

ago. Instead, we entered the war with discovered unproduced reserves at an all-time peak, although our production rates had climbed to a level four times larger than in World War I. This situation enabled the U. S. to produce the unprecedented volumes that had so much to do with winning the war. A healthy, active industry saved our supply of petroleum, and perhaps the life of the nation, through progress which could not have occurred except under the favorable competitive conditions that existed almost exclusively in the U. S.

Copper is an example of the ore mining industries. Like petroleum, this industry has been confronted with cries that its supply was being exhausted. Two generations ago copper mining was confined to deposits yielding about an 8 percent ore. Through the years, improved methods permitted the development of new copper resources that assayed less than the previous economic limit. As these new fields were opened, production always rose to higher levels, costs always were reduced, and our raw resources of copper multiplied many times. It became possible to work copper deposits assaying as low as 0.7 percent ore between World War I and World War II.

All this boils down to the definite conclusion that technological progress is the indispensable finder, developer, multiplier and conserving agent of natural resources. Therefore, our most important mineral resources do not consist of the number of barrels of oil or pounds of copper that we can point to in the ground, but rather technical research supported by a healthy and vigorously competitive industry. Given a fair chance, industry will accomplish even more in the future than in the past. This requires the use of our minerals, so our mines and wells can remain in operation.

Consequently, the most essential element of a national mineral resource policy is to leave industry free to develop on a tried and proven basis, and to shun the adoption of measures which would attempt to regiment or retard research, destroy the incentives of invention, or prevent the free play of competitive enterprise. Such a policy is the best kind of insurance against a shortage of minerals in time of war or peace.

Mandatory Unitization NEEDED

FOR MAXIMUM U. S. OIL RECOVERY

By SIDNEY A. SWENSRUD
Executive Vice President, Gulf Oil Corporation, Pittsburgh

THE AUTHOR suggests that the petroleum industry should seek state laws and regulations requiring unit operation as a means for obtaining maximum recovery of oil and gas from U. S. reservoirs. Normal and regular applications of unitization are needed, he asserts, in the interest of conservation and the public welfare and in order to assure the greatest possible domestic supply of petroleum.

I DO NOT see how anyone can tell what our future oil and gas discoveries in this country will be, but it is hard to imagine them being so great that we could afford to be indifferent to the best possible operation of the properties we have already discovered.

We have long since come to recognize that the law of capture and unrestricted production were not satisfactory or adequate for a mature oil industry. A great industry, fulfilling such an important role in our national life, could not be allowed to rest upon a supply foundation of extreme instability subject to the vagaries and caprice of unregulated rates of production, with a prolific and wasteful feast one day and a dire famine the next.

The change in our ideas did not come easily, however—there were doubts as to the probable effectiveness of the new rules, and suspicion as to the motives of those who would impose them. Particularly there was apprehension over the role which many felt that the federal government logically would have to play in such a picture in order to arbitrate and set quotas as between various oil states with the whole business perhaps ending up in complete government control. But be it said to the everlasting credit of the oil states and the members of the industry, that with a minimum of aid from the federal government, through such devices as the Interstate Oil Compact Commission, the art of oil regulation by the states has made great progress and has reached the point where it is now regarded by most oil men as necessary and desirable.

The reason for this approval, of course, is largely the fact that it has resulted in real conservation. For while the legal and legislative and regulatory ends were being developed, the petroleum engineers and geologists were finding out more and more about oil reservoirs and the physical conditions and type of operations which make for the best ultimate recoveries and lowest costs. These two forces . . . that is, engineering knowledge and education on the one hand and the development of legal and regulatory provisions on the other . . . have pretty much marched along together.

From an address given before the Texas Mid-Continent Oil and Gas Association at San Antonio, Texas, October 16, under the title, "The Production Job of the Oil Industry."

Legislation Lags

It seems to me, however, that at the present time the engineering end has gotten a little ahead of the other end in most of the oil states. What I have in mind is that we do not yet have the legal or legislative basis in most of the oil states for the degree of unitized type of operations which the engineers more and more are finding to be essential to almost any program for the best development and operation of an oil, gas or distillate field. The earlier idea, of undertaking some form of "secondary" recovery when the primary method had petered out, so to speak, has largely given way to the concept that primary and secondary recovery should all be thought of as one integrated phase embodying the best method of developing and producing the field from beginning to end, so as to get the best possible utilization of the initial pressures and energy within the pool, and to recover the greatest possible quantities at the lowest possible capital and operating costs. I include operating costs as a part of conservation because the only oil that can be conserved is the oil that can be produced at a reasonable cost in relation to the market price.

We need have no apologies, therefore, for having the reduction of costs as one of the major objectives of unitization, because that is a true conservation measure. But almost every program-pressure maintenance, selective production, reinjection of gas or water—involves a greater degree of joint action among the owners and the sharing of the total production on some different basis than is provided for in the laws of most oil states. And in some states doubts even exist as to whether voluntary unitization agreements are safe and permissible under the anti-trust laws.

Now I think it is probable that ten years from now we will have come to regard it as the normal and regular procedure to adopt a plan of unitization for most oil and gas fields right from the outset, and, with proper safeguards for the rights of all, to make such unitization plans mandatory upon all owners in the field, including the royalty owners.

A start already has been made in this direction—in Oklahoma where a unitization law was adopted a few years ago, and in Louisiana, which has certain unitization provisions relating to gas distillate fields, or at least those involving recycling projects.

The Legal Committee of the Interstate Oil Compact Commission (consisting largely of oil industry lawyers) has prepared a proposed unitization statute

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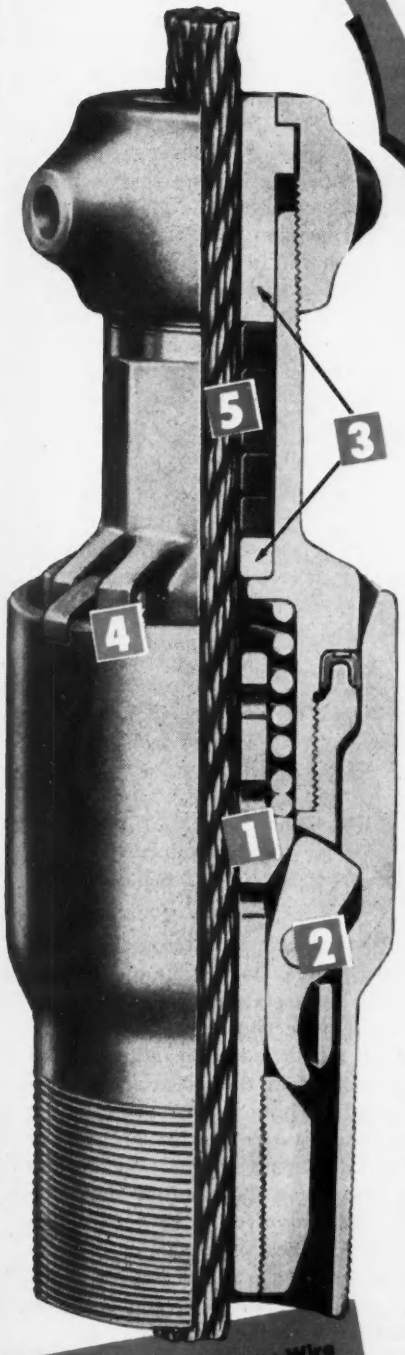

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which the Compact Commission has recommended to all oil states.

The Oklahoma statute and the proposal of the Interstate Compact Commission seem to contain the essentials for preserving the same sound balance between the industry and the states that has been the source of success in oil regulations up to now. What they provide for in effect is that, when a majority of the owners (or the ownership) in a pool believe that some form of unitized operation is desirable, they may propose a plan. It is to be noted that the initiative here lies within the industry and must come from the owners. And who could be more directly concerned, and better able to propose a sound and sensible plan for increasing the total recovery and reducing costs than the principal owners in an oil pool?

When such a plan has been proposed it becomes the duty of the duly constituted oil authorities in the state to examine its technical features, to study the equity of the proposed way of dividing up the production among the owners, to hold hearings, and to permit every minority owner to have his day in court, so to speak, to present and argue his objections and his ideas. When this has been done and a plan has been devised which is found to be fair to all concerned and in the public interest, then it can be ordered into effect by the state authority and made obligatory on all owners, with a further safeguard that if, regardless of their reason or the engineering merit of their position, a substantial minority opposes the plan it still may not be put into effect. In Oklahoma 15 percent of the ownership can veto an approved plan, while the Compact Commission proposal recommends that 25 percent be required for such veto. In respect to such veto provision and as to other aspects, including satisfactory provisions for reasonable flexibility in the modification of original proposals or plans, ideas will vary, and undoubtedly further study and time and experience will permit many desirable improvements.

But certainly it is hard to see who should be opposed to this basic type of law which should be carefully distinguished from any compulsory law that would give to a state agency the arbitrary authority to put into effect a unitization plan of its own, making and enforcing it upon all owners regardless of their choice or views. What we are talking about is rather a means of enabling a great majority of owners in a field to work out and institute in a democratic way, and with proper safeguards for the minority, plans for local self-government for the best operation of a field. It is a step away from the kind of detailed state regulation of each individual well that usually is required for best conservation that can be had in the absence of a unitization plan. The sound engineering reasons for unitized methods of operation have been proven beyond question, we believe. And certainly our concept of freedom and of law does not go so far as to permit small minorities to hold out unreasonably and to prevail against the rights of others and against the public interest. In all parts of our system it becomes necessary at some point to require that those who will not voluntarily do so must go along with what the great majority believe, and the duly constituted authorities find, to be desirable.

About the Author

SIDNEY A. SWENSRUD was graduated from the University of Minnesota in 1923 and then joined Washburn-Crosby Company (now General Mills). In 1925 he went to the Harvard Graduate School of Business and graduated with distinction in 1927 with a master's degree in business administration. In August, 1928, he became assistant to the president of the Standard Oil Company of Ohio, and was made vice president in charge of production, supply, and transportation in August, 1939; a director in April, 1940; and executive vice president in 1946. He was elected executive vice president and member of the board of directors of Gulf Oil Corporation this year.

Sources of Opposition

The opposition to such plans may come from a variety of causes. It may be an honest conviction that the particular plan is unsound or unfair. It may be an unreasoned prejudice against any form of control; it may be mere neglect or indifference; or it may be an ulterior purpose of obtaining benefits without payment or of being bought out on a nuisance value basis. Whatever the reasons, and undoubtedly all of them apply at different times, it seems to me that we now have reached the point where the importance of maximizing the recovery of crude, gas and distillate reserves, and minimizing the recovery costs, has become so great that we should increase our efforts to speed up the adoption in all the oil states of unitization laws along the lines we have been discussing.

The oil industry should also continue vigorously to urge the clarification, and if necessary the modification, of the anti-trust laws, both state and federal, so that there may be no barrier to proper unitization operations from that source. I do not believe either the states or the federal government desire to frustrate proper conservation by any unreasonable application of their anti-trust laws, but such developments as the recent case brought by the Attorney General of the U. S. against the participants in the unitization plan for the Cotton Valley field in Louisiana have raised doubts which must be resolved.

If proper unitization involves the operation of a jointly owned facility such as a recycling or extraction plant, there must be reasonable opportunity to carry on the joint activity in the manner and to the extent which is normal and efficient for such an operation, for as we emphasized before, economy and reduction in operating costs is an important and vital part of conservation. As for state laws, there are some people in Texas, for instance, who feel it unsafe to join in voluntary unitization agreements because of uncertainty and fear as to their status under the anti-trust laws of the state.

If I am correct that as of now the legal, legislative and regulatory end is lagging in some states behind tested and accepted engineering ideas and principles, then I believe the oil industry may very properly take the initiative in advocating and pushing the necessary steps to clear the way for further progress. I believe the industry should take the initiative because it understands the engineering facts involved, it recognizes the broad importance of conservation, and it has an interest in preserving the present type of regulation by the states in cooperation with the industry.

As I said before, I have no doubt that ten years from now we will have worked this all out. But as the lawyers say, "Time is of the essence." It may be later than we think, and the sooner we can accomplish these things the greater will be our production and our reserves, and the more successfully the oil production end of the industry in the U. S. will be able to meet the challenging requirements of these times.

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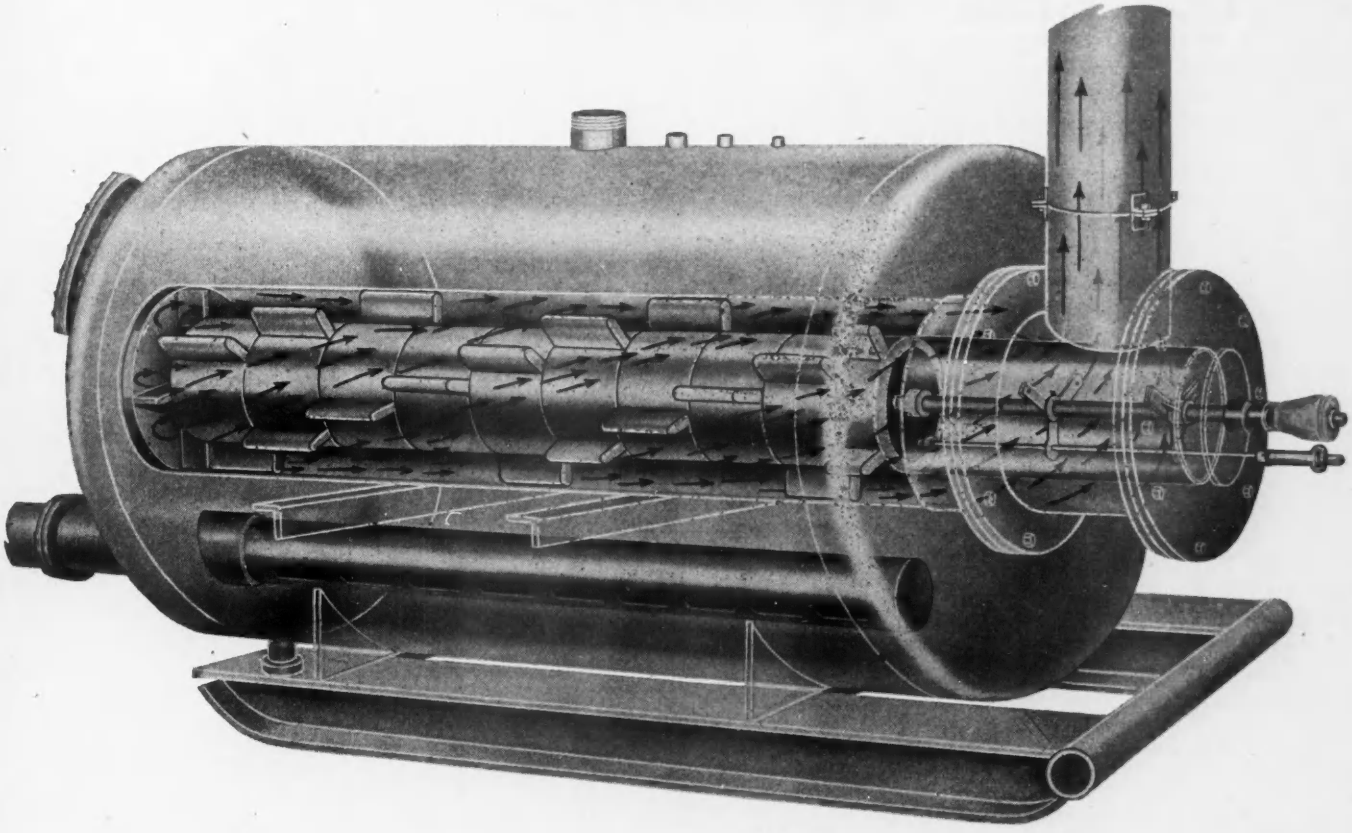

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Greater Recovery From Known Fields Needed

By W. J. MURRAY, JR.
Member, Railroad Commission of Texas

THERE are just two things which can be done to perpetuate the petroleum industry of the U. S. One is to find new reserves, and the other is to find more efficient means of recovering the oil which has already been discovered. I think the importance of the exploration program for oil is apparent, but I wish to discuss the phase of increasing the recovery from oil fields already discovered.

Under our present methods of production, we are leaving more oil in the ground than we are recovering. Just what our average percentage of recovery has been to date, I would hesitate to say. One geologist has estimated that while there are about 22 billion barrels of oil which we predict we are yet to recover from the fields already discovered in the U. S., there will remain trapped in the ground in these fields, some of which have been abandoned but most of which are still producing, some 70 billion barrels of crude. Another writer has estimated 100 billion barrels.

Any sound plan for increasing oil recovery therefore should be gladly considered. Although I have no new technique to offer, no scientific discovery to announce, I do have a plan which I sincerely believe could result in billions of barrels of additional oil recovery. It isn't original with me. I claim no credit for it. I can state the plan only in general terms.

There are three phases to this plan. The first is research. The second is putting into practice what we discover through research. The third is telling the public about the program.

Logic would dictate that these phases be carried out in the order in which they were named, but I believe that existing circumstances require a reversal of this order.

Getting Support of Public

We ought to let the people know we are leaving a lot more oil in the ground than we are getting out, that they have a stake in this unrecovered oil, and that they can do something about it. When the people have been informed by what they realize are engineering facts and not propaganda, an aroused public opinion will demand the type of legislation that is needed to further conservation. The people will demand an efficient state regulatory body adequately staffed with competent and reasonably paid experts in the field of conservation and will demand of the oil producers that they continue to strive to develop new techniques for increasing oil recovery and that these techniques be put into practice as soon as they are developed. Furthermore, this public opinion, while standing careful guard against any waste of public funds, will see to it that an adequate portion of the taxes already levied upon the oil industry for conservation purposes are made available and actually used for the administration of conservation regulations and for the conduct of research by our state universities.

The second phase of this program of increasing recovery of oil lies in putting into practice the techniques of efficient recovery which already have been proven practical and economically sound. In many fields we are not putting into practice techniques of pressure maintenance, repressuring, water-injection and reservoir control which we know would increase recovery and would be economically sound. There are various reasons for failure to put these proven practices into operation. Perhaps it is the lack of adequate state laws permitting cooperative conservation measures. Perhaps it is the lack of adequate regulation and policing by the state conservation commission, which, in turn, is likely due to an inadequate staff of conservation experts. Perhaps it is fear of anti-trust suits or Federal Power Commission regulations. Perhaps it is an unwillingness on the part of some producers to cooperate with the others in the fields to the extent necessary to make a conservation project successful. Perhaps it is a lack of general dissemination of knowledge among all producers of techniques which certain producers have found to be successful.

Most of these failures to adapt conservation measures relate, I believe, to the need previously discussed for a more enlightened public opinion. If the public can become informed of the need for conservation and can have a reasonable understanding of the process, it will . . . while standing firm against abuses and against any real anti-trust violations . . . nevertheless, see to it that no unreasonable federal or state regulations stand in the way of true conservation. Likewise, such public opinion will protect the rights of every producer whether he be a small independent or major company, but will not permit that producer to operate his properties in such a fashion as to destroy the property of others or to prevent the state as a whole from enjoying the benefits of increased recovery. But after securing the backing of public opinion and such legislation as may be necessary, it is up to the engineers of the oil industry to stay abreast of every new technique for improving recovery which is discovered and to be constantly aggressive to find places where these new techniques can be put into practice. It is the engineer's responsibility to urge the management to spend the money necessary to build a repressuring plant or to inject water or to rework wells so as to reduce gas-oil ratios or whatever it is that will result in increased recovery.

More Research Needed

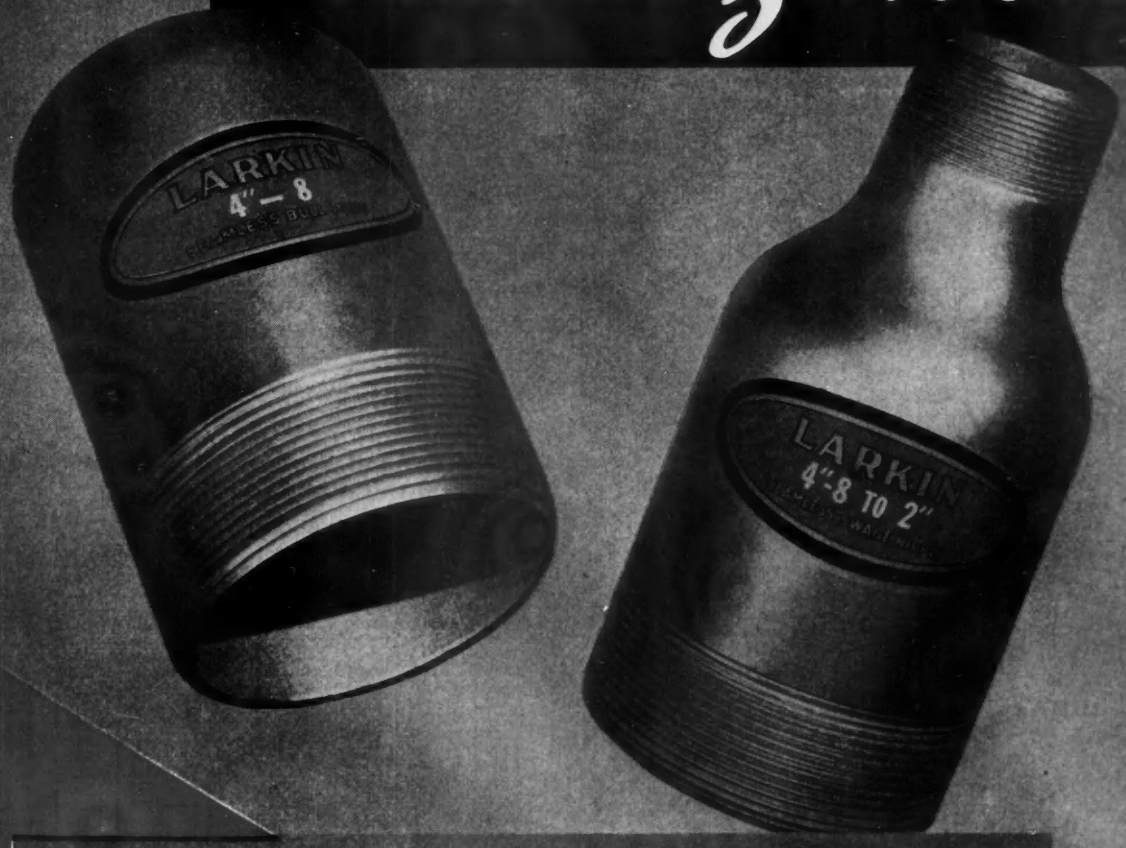
Finally, in this plan for increasing recovery comes the urgent need for a vastly expanded research program. While the research programs of some companies are to be praised, I do not believe that the industry as a whole is carrying on nearly enough research or is it adequately correlated in order to obtain the most benefit from the work that is done. Certainly, in the field of research by some of our state universities are we woefully lacking. The University of Texas, for example, largely supported by income from oil on University lands, has essentially no research program for increasing oil recovery; and Texas A. & M. College, which receives one third of the income from the Texas University lands, does not even offer graduate work in petroleum engineering. Pennsylvania, however, with only a fraction of the oil potentialities of Texas, has a substantial state-supported research program, which has been a good investment. When that research program was started, Pennsylvania was considered virtually finished as an oil producing state. But the program promoted techniques for increasing recovery, and subsequently, Pennsylvania has produced more oil through secondary recovery projects than it had produced before by primary methods. To assure funds for research in the universities of the oil producing states, a public opinion informed as to this need is essential.

From a talk before the Houston chapter, AIME, October 14, 1947, entitled, "A Plan for Increasing Oil Recovery in Texas."

IMPROVED AGAIN

LARKIN SWAGE NIPPLES AND BULL PLUGS ARE NOW FURNISHED WITH A RUST-FREE FINISH INSIDE AND OUT

THEY'RE *Zincoted*



Larkin Swage Nipples and Bull Plugs resist rust and corrosion both ***inside and out***. No other finish gives you this double protection. Exhaustive tests in a live steam bath have proved that the new ZINCOTING is still unharmed after conventional finishes have rusted and discolored. Compare the NEW ZINCOTED Larkin fittings on your supply store shelves. ZINCOTING was developed by Larkin as another step in furnishing the finest fittings that can be made.

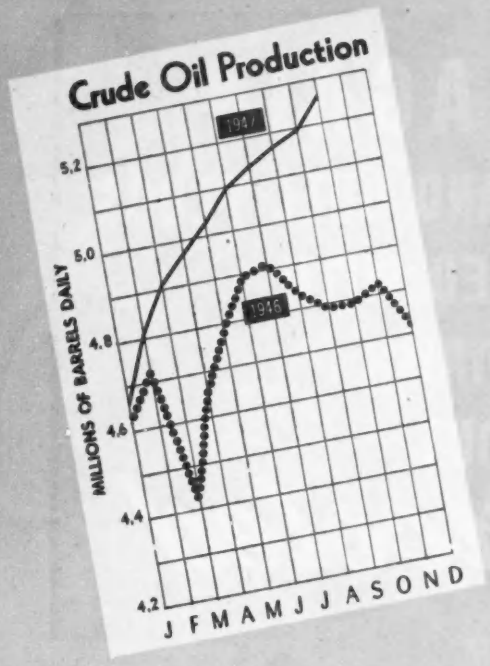
LARKIN PACKER CO., INC. • ST. LOUIS, MO.

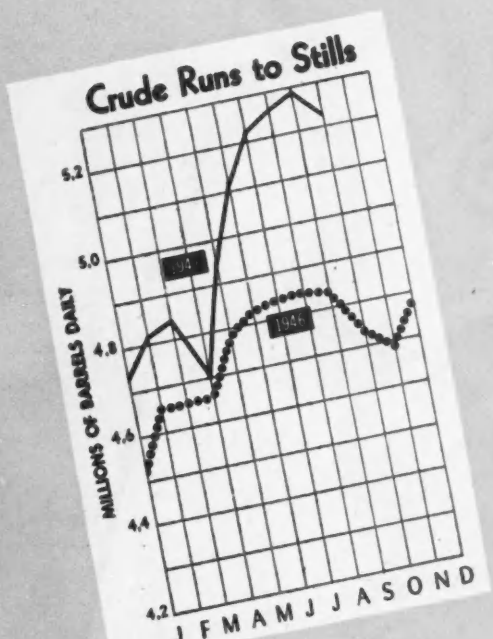
LARKIN

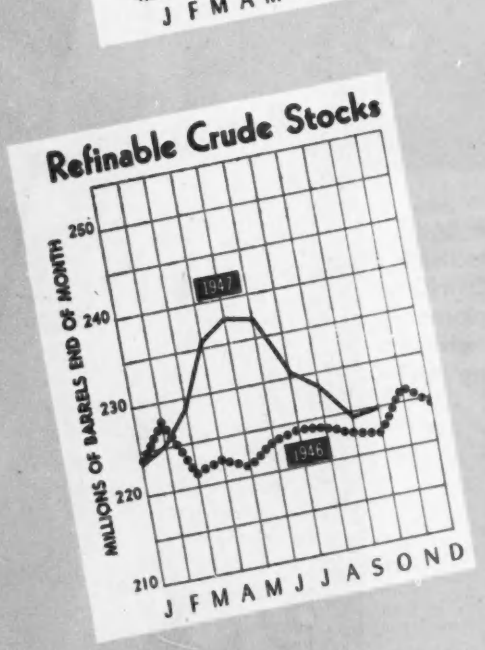
...Through Your Supply Store

Crude Processing off

By CECIL SMITH







GRUDE oil output from U. S. fields was boosted to the highest level in history during October, and while the processing of crude was carried on at a high rate it was down somewhat from September's record-breaking activity. The drop in refining operations was due principally to a slackening on the East Coast because of inadequate transportation of crude to that area, but declines in several areas where transportation does not offer such a problem seem to indicate refiners' inability to maintain such high rates of operation for lengthy periods.

Production of gasoline and the industrial fuel oils dropped slightly from the previous month's output, but continued heavy demand for these products prevented much reduction. Favored in the month's processing were the lighter domestic fuel oils, which are now entering into their heavy season. Although demand for these fuels was fairly high during the month, some of this increased output was added to stocks.

Daily crude production averaged 5,263,000 barrels in October, an increase of 65,000 barrels daily over September's rate and a new all-time peak in daily output. This also was an increase of 478,000 and 979,000 barrels daily over that produced in October, 1946, and 1947, respectively. Texas accounted for slightly over 58 percent of the nation's production increase and in so doing established a new production peak for the state. Texas' daily production averaged 2,373,000 barrels.

October's daily crude runs to refinery stills, averaging 5,225,000 barrels, failed to hold the pace set by the two preceding months' record-breaking operations. These daily runs were 62,000 barrels less than those of September, but they topped October's of a year ago by 489,000 barrels and were 981,000 barrels greater than runs in the same month of 1945. In processing

Crude Oil and Refined Products Trends

(THOUSANDS OF BARRELS)

MONTH	CRUDE OIL			GASOLINE		DISTILLATE FUEL		RESIDUAL FUEL	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month
1945:									
January	4,756	4,680	221,737	2,094	91,666	663	31,695	1,350	44,347
February	4,767	4,817	220,221	2,194	97,457	724	27,210	1,326	39,760
March	4,804	4,719	223,988	2,124	97,447	675	26,729	1,273	35,451
April	4,807	4,774	224,229	2,127	90,804	681	29,148	1,289	34,418
May	4,887	4,913	223,151	2,179	88,530	708	29,511	1,341	34,333
June	4,859	4,989	218,218	2,166	86,128	730	32,440	1,351	35,606
July	4,897	5,001	216,638	2,281	85,582	713	36,276	1,351	38,341
August	4,870	4,928	215,135	2,269	84,008	701	41,245	1,329	42,227
September	4,423	4,275	220,319	1,933	74,574	640	45,059	1,139	42,822
October	4,284	4,244	221,246	1,888	76,805	613	45,479	1,176	42,068
November	4,517	4,624	218,916	2,156	86,540	665	44,562	1,265	41,322
December	4,472	4,574	218,763	2,056	97,676	693	35,778	1,245	37,158
1946:									
January	4,625	4,520	223,442	1,914	102,394	787	28,990	1,224	34,573
February	4,719	4,651	227,220	1,884	104,836	823	25,511	1,243	34,008
March	4,414	4,661	221,400	1,900	104,161	816	29,922	1,213	32,995
April	4,673	4,663	222,480	1,943	98,744	773	32,064	1,247	35,206
May	4,785	4,794	221,592	2,016	93,960	753	33,385	1,220	38,932
June	4,896	4,836	223,140	2,055	91,971	777	38,824	1,219	41,492
July	4,922	4,856	224,351	2,102	87,778	793	46,439	1,163	45,446
August	4,836	4,856	224,157	2,189	86,745	765	54,068	1,159	48,186
September	4,790	4,839	222,417	2,143	87,021	796	62,019	1,150	54,012
October	4,785	4,736	22,177	2,117	85,952	788	76,780	1,090	55,580
November	4,823	4,684	226,453	2,162	88,587	791	68,145	1,101	52,735
December	4,725	4,780	224,473	2,168	92,742	805	59,912	1,159	47,094
1947:									
January	4,671	4,739	223,848	2,078	99,623	778	48,197	1,174	41,550
February	4,810	4,820	225,121	2,089	103,672	777	36,901	1,228	48,480
March	4,908	4,843	228,981	2,076	105,679	825	31,423	1,222	37,403
April	4,974	4,707	235,710	2,037	101,724	764	30,268	1,148	36,455
May	5,033	4,947	237,768	2,128	95,209	805	34,279	1,204	39,992
June	5,137	5,221	230,974	2,302	86,003	847	46,444	1,244	47,600
August	5,173	5,260	228,523	2,383	85,849	869	54,707	1,245	51,334
September	5,198	5,287	224,666	2,345	82,101	886	60,328	1,244	51,897
October	5,263	5,225	224,926	2,336	82,079	928	62,728	1,226	51,955
October, 1947 Changes:									
In Month	+65	−62	+260	−9	−22	+42	+2,400	−18	+58
In One Year	+478	+489	+2,749	+219	−3,873	+140	−14,142	+136	−3,625
In Two Years	+979	+981	+3,680	+448	+5,274	+315	+17,249	+50	+9,887

Trends

From September Peak

Staff Writer

October's crude the industry used 92.1 percent of the total refining capacity, while in the previous month 93.2 percent was utilized.

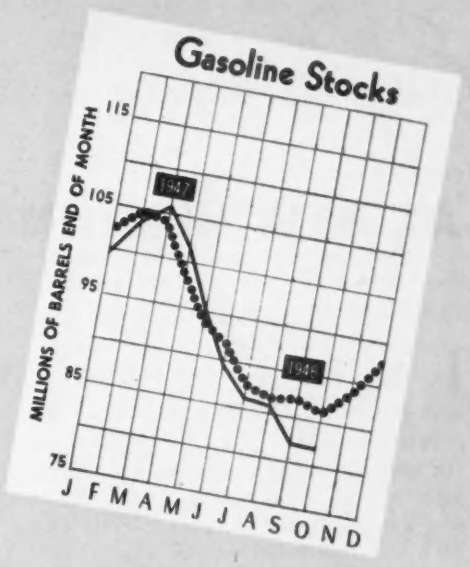
Refinable crude oil stocks increased slightly during the month and ended the period at 224,926,000 barrels. That represented an increase of 260,000 barrels during October and also an increase of 2,749,000 and 3,680,000 barrels over one and two years ago, respectively. Stocks of refinable crude are currently about 19½ million barrels less than at this time in the last prewar year.

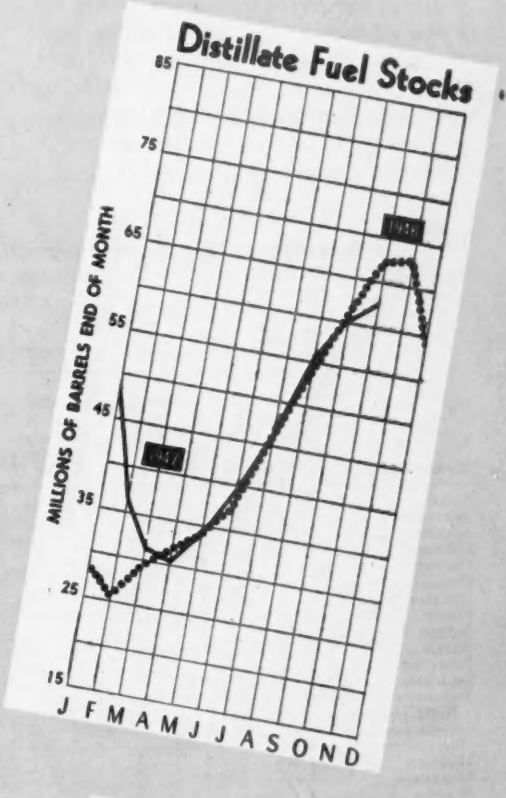
Gasoline manufacture in October was lowered 9000 barrels a day from September's output and amounted to 2,336,000 barrels daily. That amount topped last October's average by 219,000 barrels and was 448,000 a day greater than output in same month two years ago. Despite this high gasoline production, stocks had to be reduced to meet the continued heavy demand. Finished and unfinished gasoline stocks at the end of October totaled 82,079,000 barrels, a decrease of 22,000 barrels since the start of the month. However, these withdrawals from stocks were very small and seem to indicate that the turning point when daily make will more than supply needs is near. About this time each year gasoline demand slackens enough to permit the buildup of stocks to begin, and by the end of November this upward swing should be well under way.

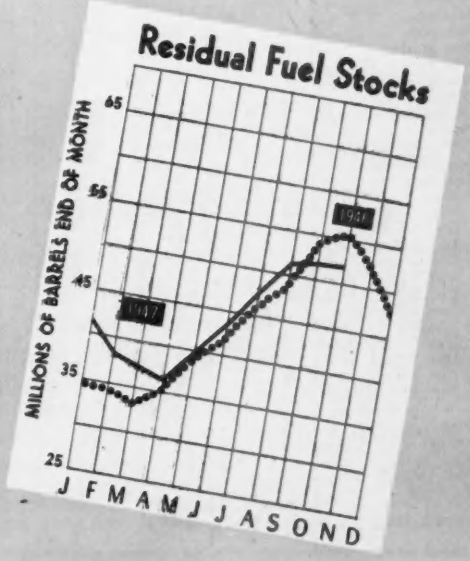
Refinery output of the distillate fuel oils jumped 42,000 barrels a day over September's production, averaging 928,000 barrels daily in October. Stocks of these oils rose 2,400,000 barrels during the month and now total 62,728,000 barrels. That amount was 14,142,000 barrels less than was in storage a year ago. While stocks are low compared with a year ago, the real problem in supplying needs this winter will not be so much the supply, but the transportation necessary to get the supplies where they are needed.

State Crude Oil Production
(THOUSANDS OF BARRELS)

STATE OF DISTRICT	Daily in September, 1947	DAILY AVERAGE IN OCTOBER			TOTAL FIRST TEN MONTHS		
		1946	1947	% Diff.	1946	1947	% Diff.
Alabama	1.1	1.0	1.3	+30.0	321	319	— 0.6
Arkansas	76.6	78.5	77.9	— 0.8	23,540	24,323	+ 3.3
California	919.2	865.7	920.7	+ 6.4	261,807	276,586	+ 5.6
Colorado	48.2	38.0	48.0	+26.3	9,695	12,928	+ 33.3
Florida	0.9	.....	0.8	.....	46	213	+ 363.0
Illinois	173.5	211.3	173.8	—17.7	63,186	55,245	— 12.6
Indiana	17.5	18.7	17.2	— 8.0	5,649	5,167	— 8.5
Kansas	294.8	278.2	298.0	+ 7.1	80,626	87,327	+ 8.3
Kentucky	25.5	28.2	25.6	— 9.2	8,943	7,720	— 13.7
Louisiana	433.8	409.7	443.4	+ 8.2	118,062	130,994	+ 11.0
North Louisiana	100.8	90.5	103.1	+13.9	25,048	29,944	+ 19.5
South Louisiana	333.0	319.2	340.3	+ 6.6	93,014	101,050	+ 8.6
Michigan	44.7	46.3	46.2	— 0.2	14,376	13,294	— 7.5
Mississippi	102.1	76.2	104.2	+36.7	19,210	28,345	+ 47.6
Missouri	0.1	0.1	0.1	.....	43	46	+ 7.0
Montana	24.3	23.6	24.1	+ 2.1	7,465	7,158	— 4.1
Nebraska	0.6	0.6	0.6	.....	232	181	— 22.0
New Mexico	117.7	103.8	117.6	+13.3	30,567	33,411	+ 9.3
New York	13.4	13.8	14.0	+ 1.4	4,076	4,005	— 1.7
Ohio	8.8	8.4	9.5	+13.1	2,426	2,565	+ 5.7
Oklahoma	397.3	358.2	401.6	+12.1	112,668	116,273	+ 3.2
Pennsylvania	33.7	37.4	35.0	— 6.4	10,865	10,512	— 3.2
Tennessee	0.1	.....	.....	.....	9	8	— 11.1
Texas	2,355.2	2,072.4	2,373.0	+14.5	634,122	674,178	+ 6.3
Dist. 1—South Central	24.2	19.8	24.4	+23.2	5,881	6,613	+ 12.4
Dist. 2—Middle Gulf	160.7	146.7	162.1	+10.5	42,824	47,348	+ 10.6
Dist. 3—Upper Gulf	499.1	453.6	492.7	+ 8.6	139,894	145,094	+ 3.7
Dist. 4—Lower Gulf-S.W.	248.2	215.7	259.5	+20.3	66,171	72,485	+ 9.5
Dist. 5—East Central	40.9	40.1	41.1	+ 2.5	12,141	11,720	— 3.5
Dist. 6—Northeast	427.7	419.7	438.1	+ 4.4	131,917	132,157	+ 0.2
Dist. 7-B—N. Central	41.1	33.2	43.7	+31.6	9,855	11,632	+ 18.0
Dist. 7-C—W. Central	41.2	27.3	40.7	+49.1	8,266	11,172	+ 35.2
Dist. 8—West	637.6	490.3	645.7	+31.7	150,010	166,539	+ 11.0
Dist. 9—North	128.2	125.0	135.9	+ 8.7	37,709	39,713	+ 5.3
Dist. 10—Panhandle	86.3	82.0	89.1	+ 8.7	25,439	25,896	+ 1.8
Virginia	0.1	0.1	0.1	.....	3	59	+1,866.7
West Virginia	7.2	8.3	7.7	— 7.2	2,478	2,144	— 13.5
Wyoming	122.2	106.1	122.3	+15.3	31,864	35,587	+ 11.7
Total United States	5,198.6	4,784.6	5,262.7	+10.0	1,442,279	1,528,588	+ 6.0







Exploration

AT NEW HIGH IN OCTOBER

IN THIS period of record production and demand the drilling branch of the industry continues to push itself to meet the nation's heavy requirements. In October the search for new sources of oil and gas continued at record levels and as a result the number of exploratory ventures completed during the month hit a new all-time peak. Despite serious pipe shortages that are plaguing this year's drilling program, exploration is being carried on at unusually high rates and will result in 1947 becoming the No. 1 wildcatting year.

Exploratory well completions during the first ten months of this year totaled about 14 percent above those of last year's comparable period, and by the end of 12 months will easily top the 4842 exploratory wells completed in 1946, which was the all-time record. The overall drilling campaign, exploratory and development, continues to hold a lead over last year's, but does not show the percent increase in completions that exploration alone does.

October's exploratory well completions totaled 592, an increase over the previous month's 500 and over the year's previous high of 524 in July. Of October's wells, 115 were finaled as suc-

Summary of Results of Exploratory Drilling

ITEM	Oct., 1947	Sept., 1947	TEN MONTHS: JAN.-OCT. 1947	1946	Percent Dif.
Oil Discoveries	76	65	586	432	+ 35.7
New Fields	51	41	345	261	+ 32.2
New Pays	25	24	241	171	+ 40.9
Distillate Discoveries	11	6	85	58	+ 46.6
New Fields	4	2	38	26	+ 46.2
New Pays	7	4	47	32	+ 46.9
Gas Discoveries	11	17	99	99	.....
New Fields	9	13	74	76	— 2.6
New Pays	2	4	25	23	+ 8.7
Total Discoveries	98	88	770	589	+ 30.7
Extensions to Fields	17	37	155	182	— 14.8
Oil Fields	12	29	117	131	— 10.7
Distillate Fields	2	4	15	4	+275.0
Gas Fields	3	4	23	47	— 51.1
Total Prod. Tests	115	125	925	771	+ 20.0
Dry Holes	477	375	3573	3167	+ 12.8
Wildcats	467	366	3466	3084	+ 12.4
New Pays	.....	1	49	33	+ 48.5
Outposts	10	8	58	50	+ 16.0
Total Expl'tory Tests	592	500	4498	3938	+ 14.2
Percent Productive	19.0	25.0	21.0	20.0	.....
Percent Dry	81.0	75.0	79.0	80.0	.....

Results of Exploratory Drilling in October and First 10 Months, 1947-1946, by Districts

State or District	MONTH OF OCTOBER, 1947														FIRST TEN MONTHS, 1947															
	Productive Tests										Unproductive Tests			Total Exploratory Tests	Productive Tests									Total Productive		Unproductive Tests			Total Dry		Total Exploratory Tests	
	New Fields			New Pays			Extensions			Total Productive	Wildcats	New Pays	Outposts		New Fields			New Pays			Extensions			10 Mo. 1947	10 Mo. 1946	Wildcats	New Pays	Outposts	10 Mo. 1947	10 Mo. 1946	10 Mo. 1947	10 Mo. 1946
	Oil	Gas	Dis.	Oil	Gas	Dis.	Oil	Gas	Dis.						Oil	Gas	Dis.	Oil	Gas	Dis.	Oil	Gas	Dis.								
Alabama	...	...	...	...	...	...	...	...	...	...	4	...	...	4	...	...	...	...	...	...	...	...	...	...	...	17	...	...	17	11	17	11
Arizona	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	2
Arkansas	1	...	...	...	...	...	...	...	...	1	11	...	...	12	4	...	...	3	...	1	1	...	...	9	7	56	1	...	57	42	66	49
California	1	...	...	...	...	...	...	...	...	1	25	...	...	26	8	1	...	11	...	...	7	3	...	30	28	227	...	...	227	207	257	235
Colorado	...	...	...	...	...	...	...	1	...	1	4	...	...	5	1	1	...	...	...	...	1	3	...	6	5	29	...	7	36	13	42	18
Florida	...	...	...	...	...	...	...	...	...	...	2	...	...	2	...	...	...	...	...	...	...	...	...	...	1	25	...	...	25	19	25	20
Georgia	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3	...	...	3	2	3	2
Illinois	2	...	...	6	...	...	4	1	...	13	49	...	...	62	27	...	...	50	1	...	41	1	...	120	93	352	...	...	352	439	472	532
Indiana	2	...	...	...	...	...	...	...	...	2	5	...	...	7	10	...	...	6	...	...	1	...	...	17	15	93	...	...	93	72	110	87
Kansas	7	1	...	...	...	...	...	...	...	8	46	...	...	54	47	12	...	...	...	...	2	1	...	62	77	295	...	...	295	217	357	294
Kentucky	1	...	...	...	...	...	1	...	...	2	7	...	...	9	4	...	...	1	...	...	2	...	...	7	17	45	...	...	45	71	52	88
Louisiana	2	...	1	3	...	3	...	...	...	9	24	...	...	33	15	4	7	26	...	17	4	...	1	74	73	221	6	1	228	180	302	253
North Louisiana	1	...	1	...	...	...	...	...	...	2	20	...	...	22	7	1	2	2	...	1	1	...	1	15	17	152	5	1	158	105	173	122
South Louisiana	1	...	...	3	...	3	...	...	...	7	4	...	...	11	8	3	5	24	...	16	3	...	...	59	56	69	1	...	70	75	129	131
Michigan	1	...	...	...	...	...	1	...	...	2	28	...	...	30	9	3	...	...	...	...	3	...	...	15	25	181	1	2	184	195	199	220
Mississippi	2	...	...	...	...	...	...	...	1	3	10	...	...	13	3	1	...	1	...	...	3	...	1	9	4	75	...	...	75	57	84	61
Missouri	...	...	...	...	...	...	...	...	...	...	6	...	...	6	...	...	...	...	...	...	...	...	...	...	...	15	...	...	15	16	15	16
Montana	...	1	...	...	...	...	...	...	...	1	3	...	1	5	1	1	...	...	1	...	2	...	...	5	4	11	1	2	14	19	19	23
Nebraska	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	2	3	2	3
New Mexico	1	...	...	...	...	...	...	...	...	1	5	...	...	6	4	...	...	1	...	...	2	1	...	8	5	48	5	...	53	44	61	49
New York	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1
North Carolina	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	1	1	1	1
Ohio	...	...	...	...	...	...	...	...	...	...	4	...	...	4	...	3	...	...	...	...	...	5	...	8	24	38	...	...	38	36	46	60
Oklahoma	7	1	...	1	...	...	...	...	...	9	45	...	...	54	68	15	1	4	...	...	4	1	...	93	96	454	...	1	455	297	548	393
Oregon	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	1	2	1	2
Pennsylvania	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3	3	...	...	3	4	3	7
South Dakota	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1
Tennessee	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12	...	...	12	2	12	2
Texas	22	5	3	14	2	4	6	1	1	58	182	...	8	248	139	28	30	135	23	29	40	7	11	442	278	1223	31	37	1291	1183	1733	1461
Dist. 1 S. Central	2	...	...	...	...	...	2	...	...	4	29	...	...	33	9	...	...	1	...	...	4	...	...	14	7	115	...	1	116	86	130	93
Dist. 2 Middle Gulf	...	...	1	...	...	...	1	1	...	5	8	...	2	15	8	4	14	11	6	9	3	2	1	58	[1]	94	...	6	100	[1]	158	[1]
Dist. 3 Upper Gulf	1	1	...	8	2	...	...	...	...	12	16	...	3	31	15	5	8	22	8	9	4	...	3	74	58	140	3	8	151	119	225	177
Dist. 4 L.Gulf-S.W.	2	1	1	2	...	2	1	...	...	9	26	...	2	37	22	11	6	36	7	9	3	2	5	101	65	195	2	11	208	259	309	324
Dist. 5 E. Central	1	...	...	...	...	...	...	...	...	1	10	...	...	11	4	...	...	2	...	...	2	2	...	10	[2]	58	2	1	61	[2]	71	[2]
Dist. 6 Northeast	...	...	...	1	...	...	...	...	...	1	5	...	...	6	3	2	1	3	...	2	1	...	1	13	21	41	3	2	46	84	59	105
Dist. 7-B N. Central	6	3	1	1	...	...	...	...	...	11	29	...	...	40	31	4	1	23	...	...	1	...	...	60	[3]	200	7	1	208	[3]	268	[3]
Dist. 7-C W. Cent.	3	...	...	1	...	...	...	...	...	4	4	...	...	8	12	...	...	3	...	...	4	...	...	19	[4]	29	2	1	32	[4]	51	[4]
Dist. 8 West	5	...	...	1	...	...	1	...	...	7	12	...	...	19	16	...	...	13	2	...	12	...	...	43	44	102	5	5	112	145	155	189
Dist. 9 North	2	...	...	...	...	...	1	...	1	4	40	...	1	45	18	2	...	21	...	...	6	...	1	48	83	232	5	1	238	478	286	561
Dist. 10 Panhandle	...	...	...	...	...	...	...	...	...	...	3	...	...	3	1	...	...	...	...	...	...	1	...	2	...	17	2	...	19	12	21	12
Utah	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	3	...	...	3	4	3	5
Virginia	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	2
Washington	...	...	...	...	...	...	...	...	...	...	1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	1	...	...	1	1	1	1
West Virginia	...	...	...	...	...	...	...	...	...	...	1	...	...	1	...	3	...	...	...	...	...	...	...	3	4	7	...	...	7	8	10	12
Wyoming	2	1	...	1	...	...	...	...	...	4	5	...	1	10	5	2	...	3	...	...	4	1	2	17	11	28	4	8	40	16	57	27
Total U.S.	51	9	4	25	2	7	12	3	2	115	467	...	10	592	345	74	38	241	25	47	117	23	15	925	771	3466	49	58	3573	3167	4498	3938

[1] Dist. 2 included with Dist. 4. [2] Dist. 5 included with Dist. 6. [3] Dist. 7-B included with Dist. 9. [4] Dist. 7-C included with Dist. 8.

cessful for a score of 19 percent of the total. September had shown a better average of 125 out of its total for 25 percent productive. However, the difference between the two months' records was mostly in the number of major extensions to proven fields, with the earlier month holding a considerable edge, but this month's finds of new oil and distillate showed an encouraging increase.

In ten months of this year the industry has drilled 4498 exploratory wells compared with last year's 3938 for an increase of 14.2 percent. Not only was the total greater, but the success ratio was slightly higher. This year 925 have found the pay for 21 percent successful, while a year ago 771 producers amounted to 20 percent of the total.

Texas bettered the national average during October by completing 58 producers out of 248 exploratory tries for a little more than 23 percent. Twenty-two were discoveries of new oil fields and 14 found new oil pays in proven fields. From early observation the most important of these appear to be two new oil fields and a new oil pay, all in West Texas. Phillips Petroleum Company and The Texas Company jointly opened one of these areas in Ector County. The discovery was completed in the Ellenburger dolomite with an initial production of 2616 barrels of 44.5-gravity oil per day, and also had oil and gas showings in the Clear Fork lime. This new field is between the Andector-Ellenburger and Goldsmith-Clear Fork fields.

Another West Texas discovery of note was Andrews County's new field located by Sinclair Prairie Oil Company, Cities Service Oil Company and Skelly Oil Company. This area is on State University lands, two miles west of Shafter Lake, and production is from a formation of Devonian age. The discovery initially flowed 1036 barrels of 38.3-gravity crude per day. Also in this county, an important new oil pay was found in the Dollarhide field. A mile north of this field's production The Pure Oil Company and Humble Oil & Refining Company found the Ellenburger productive in a well that flowed 637 barrels of 44.2-gravity oil daily through ¼-inch choke. The well also indicated production from Silurian and Devonian zones that are already productive in the field.

Mississippi finaled 13 exploratory wells and gained 2 oil fields and 1 distillate field extension. One of these new finds is causing speculation that a major field may have been discovered by J. C. Hawkins et al. The discovery flowed 153 barrels of oil and 51 barrels of salt water per day from the Massive sand, topped at 10,550 feet. The new area has been named Oldenburg field and is in Franklin County.

New Oil, Distillate and Gas Fields and New Pay Horizons Discovered in the United States in October, 1947

Also Important Extensions to Established Fields

COUNTY	FIELD	COMPANY, WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
		ARKANSAS—New Oil Field						
Miller	.....	Austin E. Stewart & British-American Oil Prod Co's Bailey-Johnston 1, c ne ne 29-16s-25w. Cypress Lake Area...	10-26-47	4772	3990- 4000	Paluxy sd; L Cre.....	F 205; ¼"	30.8
		CALIFORNIA—New Oil Field						
Fresno	.....	Mission Oil Co's 42-19, 4 mi w Raisin City fld, 990s, 330w, n¼ c Sect. 19-15s-17e.	10-22-47	5237	5205- 5217	.....	F 200; 11/64"	18.5
		COLORADO—Gas Field Extension						
Rio Blanco	Piceance Crk	General Petroleum's Government 28-19, se sw sw 19-2s-95w, 2 mi e ext.....	10-21-47	3490	3347- 3383	Basal Green River sd; Eoc.	3 mln	.....
		ILLINOIS—New Oil Fields						
Gallatin	Cottonwood	National Associated Petroleum's J. C. Moye 1-A, se se ne 33-7s-9e, 2 mi sw Herald pl, 1½ mi nw Inman, N. pl.	10-28-47	2328	2314- 2328	Tar Springs sd; Miss	P 6	.....
Jasper	Hunt City, S.	Robinson & Puckett's G. Dillman 1, 1550 fr sl 660 fr wl, 18-7n-11e, 1¾ mi ne Willow Hill Consol. pl.	10-28-47	2460	2436- 2460	McClosky li; Miss	P 10; 6 wtr	.....
		ILLINOIS—New Oil Pays						
Clay	Hoosier, N.	J. W. Rudy's P. W. Bateman 1, sw se se 26-5n-7e, Cypress prod. 1½ mi ne	10-28-47	2565	2560- 2565	Cypress sd; Miss	P 28	.....
Clay	Kenner, W.	Phillips Pet's Colclasure 4, nw ne sw 23-3n-5e.....	10-14-47	3047	2869- 2891	McClosky li; Miss	P 38; 71 wtr	.....
Gallatin	N. Haven, W.	Sohio's J. W. Tedford 2, se ne se 33-7s-10e.....	10- 7-47	2936	2789- 2799	L. O'Hara li; Miss	P 7	.....
Jefferson	Woodlawn	Nash Redwine's Laney et al 1, se se se 24-2s-1e.....	10- 7-47	2217	2195- 2216	Rosiclare sd; Miss	P 7	.....
Wayne	Geff, W.	A. J. Slagter Jr's Barnard 1, (OWWO), sw ne se 4-1s-7e.....	10-21-47	3214	3199- 3214	McClosky li; Miss.	P 77; 80 wtr	.....
White	Herald, E.	C. E. Skiles' Williams 1, se sw nw 13-7s-9e.....	10-14-47	2414	2399- 2407	Tar Springs sd; Miss	P 20; 20 wtr	.....
		ILLINOIS—Oil Field Extensions						
Clay	Clay City Consol.	Wm Bell's C. T. Smith 1, sw sw nw 35-3n-8e, betwn Noble & Clay City Consol pls., ¾ mi fr both.	10-14-47	3074	2882- 2914	Aux Vases sd; Miss	P 73	.....
Clay	Passport	T. B. Dirickson's Kuenstler 1, se ne 2-4n-8e, 165 fr sl 330 fr wl, 1¼ mi n ext.	10-21-47	3025	3019- 3025	McClosky li; Miss	F 720	.....
Wayne	Clay City Consol.	D. Slape's S. O. Hosselton 1, nw nw ne 29-2n-8e, ½ mi extension.....	10-28-47	3010	3003- 3010	Rosiclare li; Miss	P 65	.....
Wayne	Clay City Consol.	D. Slape et al's F. Pettijohn 1, se nw sw 27-2n-7e, ½ mi extension	10-21-47	2986	2978- 2986	Aux Vases sd; Miss	P 95	.....
		ILLINOIS—Gas Field Extension						
Gallatin	Cottonwood	Mealy & Wolfe's L. M. Mills 1, se se sw 28-7s-9e, ¾ mi nw extension.....	10-14-47	2331	2280- 2295	Tar Springs sd; Miss	10.5 mln	.....
		INDIANA—New Oil Fields						
Miami	.....	Barsland Oil Co's Frank Tillett 4, 330 fr sl 165 fr highway 31, 21-27n-4e, 1½ mi nw old Trenton pl, near Peru.	10-24-47	848	840- 848	Trenton li; Ord	P 80	.....
Vanderburgh	Martin	John B. Buchman's Wassmer 1, ne sw sw 6-5s-11w.....	9- 3-47	2301	2286- 2296	Cypress sd; U. Miss	P 20	.....
		KANSAS—New Oil Fields						
Barton	.....	Bay Pet. Corp & H. H. & B Drlg Co's Kowalsky 1, nw nw sw 32-20-11, ¼ mi w abnd Kowalsky pl.	10-28-47	3374	3365- 3374	Arbuckle li; Ord	P 458	.....
Butler	.....	Rex & Morris' Robinson 1, nw ne nw 36-25s-3e, 1 mi n Allen pl.....	10-14-47	2723	2708- 2723	Mississippi li; Miss	P 25	42
Marion	.....	J. F. Leiker's Skelnar 1, nw ne nw 33-18s-4e, 1 mi n Antelope pl.....	10-30-47	1870	1837- 1870	Kansas City li; Penn	20	.....
Marion	.....	Frank Dieter et al's Navrat 1, ne ne sw 16-18s-4e, 2½ mi s Lost Springs pl.	10-28-47	2444	2408- 2444	Mississippi li; Miss	P 35; 35 wtr	36
Rooks	.....	Continental Oil Co's Finnesy 1, se se ne 14-10s-18w, 3½ mi n Burnett, NW pl, 5½ mi se Paradise Creek pl.	10-14-47	3763	3419- 3437	Lansing-Kansas City li; Penn	P 26; 65 wtr	.....
Rooks	.....	Continental's Eva Gick 1, ne nw ne 30-9s-19w. 3½ mi sw McClellan pl.....	10-28-47	3590	3578- 3590	Arbuckle li; Ord	P 611	34
Stafford	.....	Stanolind O & G Co's Otto Pundsack 1, se se sw 19-21s-13w. 1¾ mi w Hazel pl, 2 mi n Curtis pl.	10- 7-47	3743	3735- 3743	Arbuckle li; Ord	SW 92	27
		KANSAS—New Gas Field						
Pawnee	.....	Stanolind & Cities Service's Yeager 1, nw se sw 22-23-16, 1 mi se Zock pl.	10-28-47	4128	4087- 4105	Arbuckle li; Ord	0.5 mln	.....
		KENTUCKY—New Oil Field						
Logan	.....	S. W. Mitchell's Logsdon 1, 21-G-31, 1½ mi e Lewisburg. 15 mi fr other prod.	10-17-47	894	585- 605	McClosky li; U Miss	P 75	.....
		KENTUCKY—Oil Field Extension						
Henderson	Hitesville	Rodney Mitchell's Bertha Keilin 1, 17-P-21. 1 mi n ext. 5 mi e Uniontown.	9- 5-47	2668	2632- 2636	McClosky li; U Miss	P 200	.....
		NORTH LOUISIANA—New Oil Field						
Bossier	.....	M. A. Halsey's H. Skidmore B-1, c se se 1-16n-11w, West of Lake Bistineau	10-15-47	5837	2613- 2618	Tuscaloosa sd; U Cre	P 30; 140 wtr	.....
		NORTH LOUISIANA—New Distillate Field						
Bienville	.....	Union Producing Co's Frazier 1, c ne sw 14-14n-6w, 3 mi n 1 mi e Saline.	10-15-47	8523	6730- 6752	James li; L Cre	No gge: 10.8 mln; ¼"	.....
		SOUTH LOUISIANA—New Oil Field						
Vermilion	Warren	Stanolind O & G Co's E. M. Watkins 1, 1980 s 1325.4 w fr nec 23-13s-1w, 6 mi e Florence Twst	10- 8-47	12191	7070- 7073	.....	F 114; 1/32"	56

[1] Character of producing formations abbreviated thus: ch, chalk; dolo, dolomite; li, limestone sd, sandstone; sh, shale; sur, serpentine; cgl, conglomerate. Ages of formations abbreviated thus: Plio, pliocene; Mio, Miocene; Olig, Oligocene; Eoc, Eocene; U. Cre, Upper Cretaceous; L. Cre, Lower Cretaceous; Jur, Jurassic; Tri, Triassic; Perm, Permian; Penn, Pennsylvanian; U. Miss, Upper Mississippian; L. Miss, Lower Mississippian; Devo, Devonian; Sil, Silurian; Ord, Ordovician; Cam, Cambrian.

[2] Barrels of oil per day (24 hr. rate), flowing (F), pumping (P), swabbing (Sw), or bailing (B); or million cubic feet of gas daily open flow capacity; size of choke given in inches.

New Oil, Distillate and Gas Fields and New Pay Horizons Discovered in the United States in October, 1947

Also Important Extensions to Established Fields—Continued

COUNTY	FIELD	COMPANY, WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
		SOUTH LOUISIANA—New Oil Pays						
Acadia	Iota	Crown Central's H. T. Duson 1, 660 n 500 e fr ctr 14-8s-2w, ¾ mi se Iota discovery well.	10-22-47	9352	8792- 8826		F 298; 11/32"	30.4
Calcasieu	Vinton	Union Sulphur Co's Clean Ld & Dev Co 2, 3727.3 n 968.3 e fr swc 35-10s-12w	10- 1-47	6330	6285- 6315	Catahoula sd; Mio	P 33	33
Lafourche	Raceland	Kenneth A Meredith's South Coast Corp 1, fr common pt of Sects. 33, 34, 35, 36 go n 50 deg 35 min w 2294.82 th n 81 deg 22 min e 5273.67, th n 8 deg 38 min w 466.69 to loca in Blk 38-15s-23e.	10-19-47	10205	10010-10026		F 200; 1/8"	38.6
		SOUTH LOUISIANA—New Distillate Pays						
Acadia	Crowley	Phillips Pet Co's Onesime 2, 1973.5 e alg nl of 15-10s-1e fr nwc th s 660	10- 2-47	11940	11054-11072		F 31; 5 mln; 1/4"	43.2
Terrebonne	Four Isle Dome	Superior Oil Co's State-LLE Unit 12-2, 2848 s 3544 e fr nwc 24-21s-16e, on e side dome.	10- 1-47	14220	13455-13465		F 180; 1.5 mln; 1/4"	48.4
Vermilion	Tigre Lagoon	Union Oil Co of Calif's Billeaud-Planters 1, 660 s 1980 e fr nwc 32-13s-5e, 3000 sw P.O. Landry 1, disc, 3½ mi w Avery Island fld.	10- 1-47	12226	11638-11655		F 50; 1.8 mln; 11/64"	50
		MICHIGAN—New Oil Field						
Ionia		T. F. Caldwell's McKenna 1, sw nw se 4-8n-10w, North Plains twp	10-10-47	3036	3009	Dundee sd; Devo	P 20	
		MICHIGAN—Oil Field Extension						
Allegan	Trowbridge, N	Max Spidel's Winger 1, se se ne 7-1n-13w, ½ mi se disc. now abnd. 2 mi n Trowbridge fld.	10-31-47	1345	1341- 1345	Traverse li; Devo	P 30; 50 wtr	
		MISSISSIPPI—New Oil Fields						
Franklin		J. C. Hawkins et al's Lehmann Bros. 1, ne ne 27-7n-2e, 660 s&w of nec 1 mi w Olenburg, 8 mi e Cranfield fld.	10-16-47	10474	10550-10552	Massive sd; L Cre	F 153; 51 wtr	37.1
Jones		Union Sulphur's A. E. Fall Est 1, c nw sw nw 8-9n-10w, 2 mi se Sandersville	10-20-47	7235	5438- 5455	City Bank (Eutaw) sd; U Cre	P 9	11.3
		MISSISSIPPI—Distillate Field Extension						
Jones	Soso	Gulf's W. W. Jackson 1, ne sw 26-10n-13w, ¾ mi extension	10-24-47	6676	6667- 6676	Eutaw sd; U Cre	F 77; 3 mln; ½"	66.2
		MONTANA—New Gas Field						
Liberty		Texas Co's George Colbry 1, c sw sw 13-36n-6e, East Keith area	10-17-47	4977	2995- 3045	Madison sd; Miss	9 mln	
		NEW MEXICO—New Oil Field						
Lea		Cole-Darden Oil Co's Phillips-State 1, 660 fr s&el 30-17s-34e, 1½ mi w Vacuum fld.	10-10-47	4760	4635-	San Andres li; Perm	F 305; 1/4"	38.4
		OKLAHOMA—New Oil Fields						
Cotton	Walters	Walter Duncan's Fitzsimmons 1, sw sw se 23-3s-11w, 1 mi se gasser, ½ mi ne old shallow oiler offset by 2 dry holes.	10-30-47	1885	1875- 1885	Permian sd; Perm	P 100	
Garvin	Antioch, SE	Cities Service Oil Co's Ned Biffle 1, nw sw ne 23-3n-2w	10-16-47	5562	5398- 5445	Pennsylvania sd; Penn	F 66; 2.6 mln	50
Garvin		Sunray's Frank Romine 1, ne nw se 19-1n-2w, 1¼ mi sw Eola Deep disc	10-30-47	1780	1715- 1780	Arbuckle li; Ord	P 113	29
Logan	Iconium, NW	Woods Drlg Co's Crabtree 1, nw ne nw 4-16n-1e	10-16-47	5290	5236- 5283	2nd Wilcox sd; Ord	F 1320; 11/64"	38
Oklahoma	Witcher	Stanolind's Reinhart 1, c sw sw 30-13n-2w	10- 9-47	6406	6338-	Bois D'Arc-Hunton li; Ord	F 191; 1/2"	38
Pontotoc		F. L. Cooper's Marshall 1, ne ne nw 31-6n-4e	10-16-47	3246	3240- 3246	Wanette sd; Ord	F 73; 11/32"	41
Stephens	Duncan, NE	Mudge Oil Co's Semoritsky 1, sé nw se 24-1n-7w	10- 9-47	7188	7170- 7188	Pennsylvania sd; Penn	F 160; ½"	39
		OKLAHOMA—New Oil Pay						
Creek	Pickett Prairie	Murta-Strosier's Luker 1, nw ne ne 8-16n-11e	10-30-47	2288	2280- 2286	Dutcher sd; Penn	P 86	
		OKLAHOMA—New Gas Field						
Harper		J. M. Huber's Heironymous 1, c nw se 3-26n-24w	10-30-47	7007	5434- 5456	Pennsylvania sd; Penn	0.7 mln	
		TEXAS—District 1 (SOUTH CENTRAL)—New Oil Fields						
Atascosa	Imogene, E	Humble's Nelle-Gordon-Dinsmoor 1-B, 660 fr el 660 fr sel Tr 1, BBB&C Sur, 323.74-ac lse, 5 mi e Imogene fld.	10- 4-47	8124	8093- 8104	Edwards li; L Cre	F 32; 1/32"	33
Edwards	Wardlaw	Babb & Dillard's Wardlaw 1, 5270 fr nl 330 fr wl Sect 7, GCSFRR Sur, Blk F, 1280-ac lse.	10- 1-47	248	237- 248	Sd; U Cre	P 25	18
		TEXAS—District 1 (SOUTH CENTRAL)—Oil Field Extension						
Atascosa	Charlotte	Lewis Oil Co's Marrs McLean 1, 467 fr ne&nwl of 218.49-ac lse, P. Bluntzer Sur, 6. 1 mi e Frio Co. line. 1¼ mi sw extension.	10-25-47	5267	5177- 5267	Navarro sd; U Cre	F 77; 1/8"	38
La Salle	Washburn	Newman Bros. Drlg Co & Skinner & Eddy Corp's South Texas Syndicate 1-D, 1400 fr s&el G. W. von Roeder Sur 60. 1 mi se extension.	10- 4-47	5253	5248- 5253	Wilcox sd; Eoc	F 26; 1/64"	45
		TEXAS—District 2 (MIDDLE GULF COAST)—Oil Field Extension						
Bee	Tulsita-Wilcox	Union Producing Co's G. A. Ray 70, 80 fr nwl 6700 fr swl Geo A Kerr Sur, 38 e of railroad (wl of lse) on 16,563.02-ac lse, ½ mi ne extension.	10-17-47	7095	7077- 7095	Slick sd; Eoc	176; 1/4"	35.8
		TEXAS—District 2 (MIDDLE GULF COAST)—New Distillate Field						
DeWitt	Pena	Sunray Oil Corp's Lazaro Pena 1, 660 fr nw&swl of 100-ac lse, or 6300 fr nel 6200 fr sel Antonio Laso Sur, 1¾ mi w Slick Wilcox fld.	10- 4-47	7855	7512- 7520		No gge; 6.2 mln; open	
		TEXAS—Distrcit 2 (MIDDLE GULF COAST)—New Distillate Pays						
Jackson	Texana	Floyd L. Karsten's Geo S. Clement et al 1, (OWWO), 330 fr n&wl Blk 18, Clement Subd, Stephen F. Austin Gr, 158.08-ac lse, se flk of fld.	10-13-47	8001	6301- 6305		F 20; 2.8 mln; 1/4"	52.1
Refugio	Bonnie View	P. R. Rutherford's Henry Schirmer 14, 1267 fr el 1460 fr sl Sect 26, Johnson & Pugh Subd, Bonnie View Rch, Esteban Lopez Gr, 394 se Schirmer shallow well No. 10.	10- 1-47	6430	5632- 5636		F 54; 30 mln; 1/4"	
		TEXAS—District 2 (MIDDLE GULF COAST)—Gas Field Extension						
Refugio	Woodsboro	Southern Minerals Corp's R. H. Wood 2-A, 2550 fr sly/wl 2450 fr nearest pt on nly/nl 1276-ac lse. Anastacio Reojas Gr. 1½ mi w extension.	10-23-47	6740	5936- 5946		33.5 mln; open	
		TEXAS—District 3 (UPPER GULF COAST)—New Oil Field						
Galveston	League City Heights	H. L. Hunt's S. E. Wilson Jr. 1, 600-ac lse, S. F. Austin Lge 3 & Perry & Austin Lower Lge, 1¾ mi n League City fld, 710 fr wl 3600 fr sl Tr, Blk 45 of League City Heights Subd.	10-15-47	10152	9654- 9658		F 81; 1/8"	44.1
		TEXAS—District 3 (UPPER GULF COAST)—New Oil Pays						
Hardin	Batson, SW	Hawkins & Graham Inc's Charles G. Hooks et al 1, 134-ac lse F. H. Green Sur, Lot 5, 1717 fr el 2965.3 fr nl of Sur.	10-16-47	5530	5400- 5410	Cockfield-Yegua sd; Eoc	F 180; 1/32"	39
Chambers	Jergins	Kirby Pet Co's Fee 2, Tract 20, 330 fr nl 4017 fr el of 378.22-ac lse, C. Smith Sur.	10- 1-47	6448	6397- 6433	Frio sd; Olig	F 149; 1/8"	37
Hardin	Saratoga, NW Flk	Falcon-Seaboard & Dunwoody's Sun-Bashara 1 (OWWO), 110-ac lse, J. B. Reeves Sur, 330 fr sl 150 fr el of Tr. Disc well reworked to dually complete.	10-24-47	7380	7112- 7218	"T" sd	F 95; 1/32"	33.2
Harris	Hockley	Magnolia Pet Co's Warren Rch 2 (OWWO), 7300-ac lse, 3055 fr nl 1086 fr wl Joshua Hudson Sur.	10-27-47	6366	5728- 5735		P 86	33.4
Harris	Hockley	Magnolia Pet Co's Warren Rch 6, 7300-ac lse, 2150 fr nl 1801.2 fr el HT& B Sur 1, 4848 se well No. 2.	10-28-47	3640	3577- 3640		F 264; 1/16"	33
Liberty	S. Liberty	L. M. Josey et al's Joseph Mitchell Est 2, 916 fr sl 1793 fr wl of 160-ac lse, 3440 fr wl 916 fr sl of Mitchell 400-ac Tr..	10-27-47	7532	5892- 5902		F 101; 1/16"	38.6
San Jacinto	Mercy, W	Stanolind's Central Coal & Coke Co 1, 936-ac lse, J. G. Ferguson Sur. 1959 nw of gas-cond disc well, 660 w 3300 n of swc of manning's 80-ac farmout lse, 1½ mi w Mercy fld.	10-24-47	8381	8337- 8346		F 83; 1/8"	36
Wharton	Hutchins, S	McDonald Oil Co's K. C. Martin 6, I&GN Sur, Sect 16, 80-ac lse, also ¾ mi sw extension.	10- 7-47	6015	5849- 5901	Frio sd; Olig	F 192; 1/8"	30
		TEXAS—District 3 (UPPER GULF COAST)—New Gas Field						
Tyler		Amerada Pet Corp's Chas. G. Hooks 1, 153-ac Tr, BBB&C Sur, 6 mi e Warren Twst, 467 fr sl 1477 fr el of lse, 7 mi ne Hyatt, S. fld.	10- 1-47	9503	4925- 4930	U. Cockfield sd; Eoc	1.4 mln; 1/16"	
		TEXAS—District 3 (UPPER GULF COAST)—New Gas Pays						
Wharton		Floyd L. Karsten's F. J. Danielson 1-A, 160-ac lse, sw¼ Sect 23, ETRR Sur, 5¾ mi se El Campo Twst, 466 fr w&nl of Tr, 1100 se Tucker 1 disc gasser.	10- 1-47	7147	6724- 6728		4.6 mln; open	
Wharton	El Campo, S	Floyd L. Karsten's Frank Beal 1, (OWWO) 160-ac lse, ETRR Sur, 467 n&el of lse in se ¼ Sect 51, ¾ mi wnw Reitz 1, gas disc.	10-15-47	7050	6512- 6516		No gge	
		TEXAS—District 4 (LOWER GULF SOUTHWEST)—New Oil Fields						
Hidalgo	Robinson	Coastal Refineries Inc. & M. L. Massingill's Garcia Ld & Livestock Co. 1-A, 1 mi ne Texas' Doss No. 1 gas disc, 5 mi nw Samfordyce, 853 fr wl 31,500 fr nl of Porc 43.	10-16-47	5368	4020- 4023		F 50; 1/64"	38

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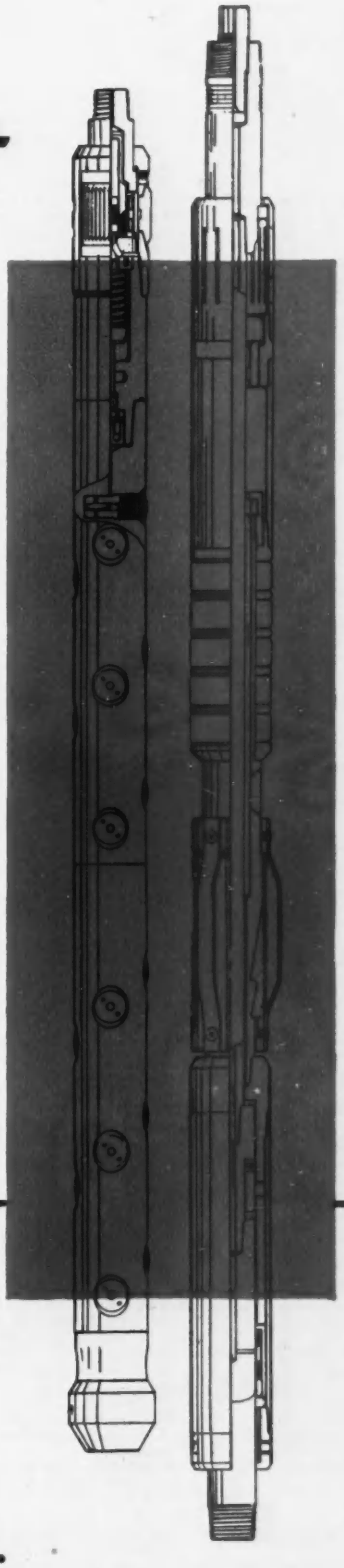

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New Oil, Distillate and Gas Fields and New Pay Horizons Discovered in the United States in October, 1947

Also Important Extensions to Established Fields—Continued

COUNTY	FIELD	COMPANY, WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
Webb	Nicholson	Humble's W. R. Nicholson 1, ne¼ sw¼ PS&F Sur 985, 1980 fr s&wl of Sur on 15,806.5-ac lse. 12 mi wnw of Lopez fld.	10-18-47	5816	5574- 5577	Wilcox sd; Eoc	F 20; 4/16"	
		TEXAS—District 4 (LOWER GULF-SOUTHWEST)—New Oil Pays						
Nueces	Sommer	Producers Development Co's W. D. Swilling 1, 230 fr sl 467 fr el of w½ Sect 25, Benton Pastr. Subd, 80-ac lse. 1½ mi s Agua Dulce.	10-31-47	6262	5896- 5904		F 73; 1/8"	38.6
Starr	Jay Simmons	Jay Simmons et al's First Nat'l Bk of Mission 2, 2½ mi se Kelsey-Deep fld, 11,120 s 467 e fr nwc of San Jose Gr.	10-29-47	6434	6430- 6433		F 176; 1/8"	43.9
		TEXAS—District 4 (LOWER GULF-SOUTHWEST)—Oil Field Ext.						
Aransas	Fulton Beach	W. H. Hunt Trust Est et al's Spencer-Kent-Crane 3, C.O.D. Gilliland Sur, 720-ac lse. ½ mi ne extension.	10- 9-47	7230	7134- 7140		F 177; 3/64"	43.5
		TEXAS—District 4 (LOWER GULF-SOUTHWEST)—New Dist. Field						
San Patricio		A. O. Morgan's Ernest H. Lane 1, 1313 fr w&sl 562-ac lse or 1313 fr sl 150 fr el Lot 30, Coleman-Fulton Pastr Co, Subd, P. Fitzsimmons Sur, 2 mi sw Sinton, S. fld.	10-12-47	7505	6660- 6675	Frio sd; Olig	No gge; 16.5 mln; open	
		TEXAS—District 4 (LOWER GULF-SOUTHWEST)—New Dist. Pays						
Brooks	Cage Ranch	Shell Oil Co's Jimmie Lenora Cage 1-C, 7800 fr el 11,000 fr sl Leonardo Vargas Sur. 7300 n of prod.	10-20-47	10006	7620- 7630		F 89; 3.7 mln; 1/4"	64
Brooks	Gyp Hill	Sun Oil Co's Perez Unit 1, 540 fr wl 1500 fr sl S. Perez Sur 334	10-15-47	7162	6774- 6830		F 83; 2 mln; 4/16"	60
		TEXAS—District 4 (LOWER GULF-SOUTHWEST)—New Gas Field						
Zapata		Rodney De Lange's E. & F. Cuellar 1, 330 fr ne&sel 80-ac lse, or 2050 fr swl 330 fr sel E&F Cuellar Sur 246. 5 mi nw Jennings fld. 9 mi nw Randado.	10- 1-47	1255	1037- 1046		No gge	
		TEXAS—District 5 (EAST CENTRAL)—New Oil Field						
Denton		Anco Gas Corp & C. B. Slemp's Bessie B. Forrester "F" 1, 330 fr sl 1850 fr wl 106-ac lse, W. Nelson Sur, 4 mi nw Bolivar.	10-24-47	1606	1598- 1606		P 28	
		TEXAS—District 6 (NORTHEAST)—New Oil Pay						
Smith	Sand Flat	Hunt Oil Co's Oliver-Black Unit 1, 467 fr s&el 40-ac Unit, 467 n of sl 30 e of wl Nettit M. Black Tr.	10-22-47	9407	9096- 9116 9132- 9140	Massive Anhydrite; L Cre	F 80; 1/4"	45.6
		TEXAS—District 7-B (NORTH CENTRAL)—New Oil Fields						
Jones		Texas Co's J. Herring 1, 1505 fr nl 330 fr wl Lot 21, De Witt CSL Sur. 15 mi sw Anson.	10-14-47	5402	5390- 5402	Ellenburger dolo; Ord	P 83; 42 wtr	44
Shackelford		F. G. & W. J. Fox et al's D. S. Griffins 1, 660 fr nel 660 fr nwl Sect 589 TE&L Sur. 4 mi ne Albany.	10-18-47	4497	4484- 4497	Ellenburger dolo; Ord	F 133; 4/12"	43
Stephens		T. P. Coal & Oil Co's A. S. Veale 9-C, 713 fr el 1771 fr sl Sect 1413, TE&L Sur. 5 mi nw Caddo.	10-10-47	3920	3908- 3920	Marble Falls li; Penn	P 47; 40 wtr	42
Stephens		Prairie O & G Co's Henry Compton 1-12, 2196 fr sl 2408 fr wl Sect 12, OAL Sur. 3½ mi sw Eolian.	10- 6-47	4347	4325- 4347	Ellenburger dolo; Ord	F 140; 1/4"	43.5
Stephens		S. D. Johnson et al's W. H. Peeks 1, 1783 fr nl 3033 fr el Sect 19, Blk 7, T&P Sur. 13 mi s Breckenridge.	10-21-47	2353	2339- 2352		P 45	44.2
Taylor		Timpkins & Ethridge's Minnie Bowles et al 1, 330 fr e&sl nw ¼ Sect 27, BAL Sur, 4½ mi ne Abilene.	10- 5-47	1900	1844- 1846		P 56	38
		TEXAS—District 7-B (NORTH CENTRAL)—New Oil Pay						
Jones	Jones Regular	J. C. Hunter Jr's Josie E. Shanks 2, 330 fr e&sl of n 107½-ac of Blk 13, R. Smith Sur 192. 4 mi ne Hawley.	10-10-47	2327	2324- 2327	King sd; Penn	P 43	40
		TEXAS—District 7-B (NORTH CENTRAL)—New Distillate Field						
Coleman		H. T. Owen & H. H. Adams' J. M. Shield 1, 1818 fr sl 467 fr wl Sect 30, T&NO Sur. 4 mi sw Novice.	10-22-47	3750	3696- 3720	Gardner sd; Penn	F 12; 1.3 mln; 4/16"	
		TEXAS—District 7-B (NORTH CENTRAL)—New Gas Field						
Brown		Roberts-Benson's Mack Henry 1, 330 fr e&sl n½ Seth Ingram Sur 154, 4½ mi e Cross Cut.	10- 1-47	2329	2175- 2207	Caddo li; Penn	F 0.2 mln; 2"	
Callahan		Star Oil Co's Tayloe & Ramsey 1, 1450 fr el 800 fr sl ne¼ Sect 319, SPRR Sur, Blk 5, 5 mi s Putnam.	10-24-47	4079	3118- 3138	Caddo li; Penn	3 mln	
Hamilton		Lone Star Prod Co's Clarence A. Rea et al 1, 1000 fr el 3000 fr sl Blk 62, Harrison Gregg Sur, 10 mi sw Hamilton.	10-15-47	3026	2793- 2827	Marble Falls li; Penn	4.5 mln	
		TEXAS—District 7-C (WEST CENTRAL)—New Oil Fields						
Crockett	[illegible]	C. W. Brown's A. C. Hoover 1-C, 1550 fr nl 330 fr el Sect 2, Blk 1, GC&SF Sur. 2½ mi ne Clara Couch pl.	10-24-47	1492	1474- 1492		F 25	26
Crockett	[illegible]	C. W. Brown's A. C. Hoover 1-D, 2310 fr nl 330 fr el Sect 10, Blk 1, GC&SF Sur. 3½ mi s Shannon pl.	10-25-47	1551	1527- 1546		P 77	26
Crockett	[illegible]	Continental Oil Co's University "A-12" 1-S 330 fr n&el Sect 12, Blk 47, University Lds Sur. 5½ mi s Barnhart pl.	10-24-47	2175	2142- 2173		P 17	32
		TEXAS—District 7-C (WEST CENTRAL)—New Oil Pay						
Crockett	Shannon-San Andres	Amerada Pet Corp's J. M. Shannon 1-B 665 fr s&wl Sect 68, Blk BB, ELRR Sur.	9-10-47	2402	2398- 2402	Grayburg sd; Perm	F 190; 2"	27.6
		TEXAS—District 8 (WEST)—New Oil Fields						
Andrews		Texmass Pet Co's Parks Est 1, 1980 fr n&el Sect 21, Blk A-34, PSL Sur. 1½ mi nw Means pl.	10-11-47	4625	4335-	San Andrews li; Perm	P 88	28
Andrews		Sinclair Prairie & Cities Service & Skelly Oil Co's University-Community 173-1 660 fr nl 1980 fr el Sect 25, Blk 13, University Lds. 2 mi w Shafter Lake.	10-13-47	9840	9688- 9828	Devonian	F 1036; 2"	38.3
Ector		Phillips Pet—Texas Co's Cowden-McEntire 1, 661 fr nl 674 fr el T&P RY Sur 18, Blk 44, T-1-N, 2 mi se Andector-Ellenburger fld.	10- 4-47	8640	8060- 8133	Ellenburger dolo; Ord	F 2616; 2"	44.5
Hockley		L. G. Yarbrough & Son and W. A. Phillips' W. T. Cobb 5-B, 440 fr n&el Tr 41, Lge 68, Hardeman CSL Sur, 2 mi w Levelland pl.	10- 9-47	4845	4790-	San Andres li; Perm	F 736; 2"	31.5
Winkler	Keystone 5000	Gulf Oil Corp's Keystone Cattle Co 48, (OWDD) 440 fr n&wl Sect 10, Blk B-3, PSL Sur.	10- 9-47	5040	4860- 4890	U Clear Fork sd; Perm	F 585; 1/2"	36.6
		TEXAS—District 8 (WEST)—New Oil Pay						
Andrews	Dollarbide	Pure Oil Co et al's E. P. Cowden 1, 660 fr sl 1980 fr wl Sect 24, Blk A-52, PSL Sur, 1 mi n prod.	10-22-47	10210	9990-10140	Ellenburger dolo; Ord	F 637; 1/4"	44.2
		TEXAS—District 8 (WEST—Oil Field Extension						
Ector	Cowden, S	Union Oil Co's E. K. Colbert 2, 1980 fr n&el Sect 43, Blk 42, T-2-S, T&P Sur, se extension.	10-13-47	4441	4345- 4372	San Andres li; Perm	P 156; 2"	34.8
		TEXAS—District 9 (NORTH)—New Oil Fields						
Archer		Stewart & Grisham's John F. O'Donohoe "A" 1, 1650 fr el 330 fr sl n½ Blk 104, ATNCL Sur. 9 mi nw Archer City.	10- 9-47	5163	3762- 3770	Strawn sd; Penn	P 17; 50% wtr	39.8
Jack		Star Oil Co's W. J. Eatherly 1, 330 fr e&sl W. B. Stramer Sur, 3½ mi w Jacksboro.	10- 7-47	5513	4886- 4896	Conglomerate	P 31	40
		TEXAS—District 9 (NORTH)—Oil Field Extension						
Archer	Vogtsberger	Republic Natural Gas Co's Mary R. Sloop 1, 1810 fr nl 2150 fr sl 466 fr wl of Sect 8, Blk 1, H&TC Sur. 6 mi se Wichita Falls.	10- 2-47	4736	4717- 4736	Strawn sd; Penn	F 112; 3/4"	42
		TEXAS—District 9 (NORTH)—Distillate Field Extension						
Jack	Steed	A. R. Dillard's Leatherwood 1, 330 fr e&sl WCRR Sur, Blk 4. 7½ mi sw Jacksboro.	10-24-47	4773	4745- 4773	Strawn sd; Penn	F 17; 3.6 mln	65
		WYOMING—New Oil Fields						
Albany		California & Phillips' M. Christiana 1, ne ne se 8-17n-77w, on Seven-mile structure.	10- 3-47	6776	5818- 5833	Newcastle (muddy) sd; U Cre.	P 100	
Fremont		Burnham & Delaney's Gov't 1, nw ne sw 14-28n-92w, 2260 fr sl 1550 fr sl 1550 fr wl of Sect. Sheep Creek Area.	10-10-47	2360	2310- 2360	Embar li; Perm	P 75	
		WYOMING—New Oil Pay						
Carbon	Hatfield Dome	Rocky Mt. Gas Co's Government 1, (OWDD), ne se nw 2-19n-88w	10-31-47	6072	5805- 6072	Tensleep sd; Penn	F 310; open	43.2
		WYOMING—New Gas Field						
Fremont	Antelope, E	Continental & General Pet's Unit 1, nw sw se 26-27n-93w, s of Crooks Gap fld.	10-17-47	6613	2157- 2180	Wasatch sd; Eoc	9 mln	

[1] Character of producing formations abbreviated thus: ch, chalk; dolo, dolomite; li, limestone; sd, sandstone; sh, shale; sur, serpentine; cgl, conglomerate. Ages of formations abbreviated thus: Plio, pliocene; Mio, Miocene; Olig, Oligocene; Eoc, Eocene; U. Cre, Upper Cretaceous; L. Cre, Lower Cretaceous; Jur, Jurassic; Tri, Triassic; Perm, Permian; Penn, Pennsylvanian; U. Miss, Upper Mississippian; L. Miss, Lower Mississippian; Devo, Devonian; Sil, Silurian; Ord, Ordovician; Cam, Cambrian.

[2] Barrels of oil per day (24 hr. rate), flowing (F), pumping (P), swabbing (Sw), or bailing (B); or million cubic feet of gas daily open flow capacity: size of choke given in inches.

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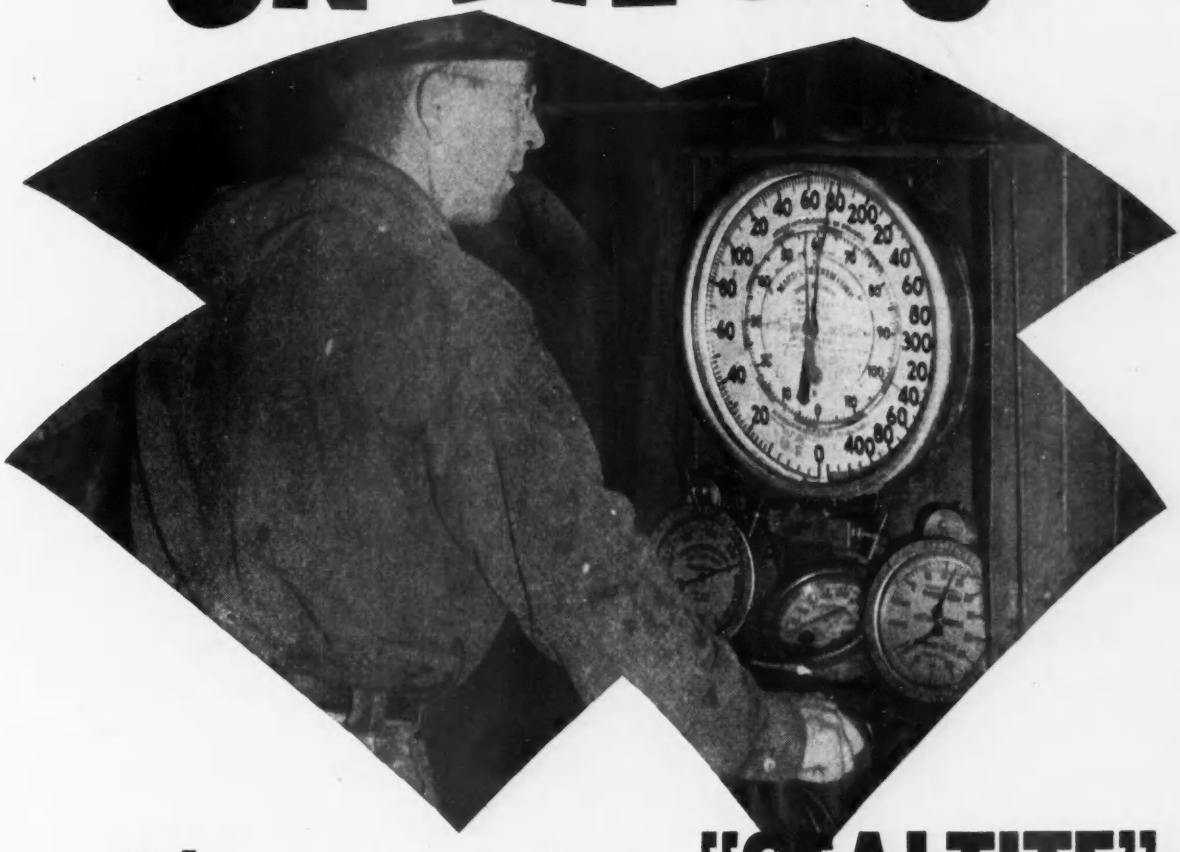

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Completions

NEAR YEAR'S PEAK IN OCTOBER

OCTOBER saw the industry's drillers continue in their determined effort to keep crude supply sources apace with the heavy demand. Drilling records showed that the month's completions increased considerably over the two previous months' and were second only to July's peak for the year.

A slight drop in activity in the final two months of the year can be expected, but operations should remain higher than were usual in previous years. In the past, winter demands for petroleum products were not as great as in the spring and summer, thereby allowing the drilling branch of the industry a convenient lull period in which to overhaul and maintain its equipment and at a time when the weather was hardest on men and machinery. However, petroleum demands have become fairly well equalized throughout the year and no longer is the fuel oil season the light period for the industry.

Although this year will not equal or exceed the all-time high in well completions, currently held by 1937 when slightly more than 35,000 wells were drilled, it will become the most active since that year. It now appears that just under 34,000 wells will have been completed by the end of December.

During October, 3266 wells were completed, an increase over September's 3005 and considerably more than the 2775 recorded in October of last year. This was the second highest number of completions for any month this year and was topped only by July's 3287. It was also the second month this year in which footage drilled totaled over 10 million feet. The first time this level was reached was in July, but then it was slightly under October's total.

Well Completions in the United States During October, 1947, and Cumulative for Year

(Figures compiled by WORLD OIL Staff from private reports and other sources as follows: Illinois from Illinois Geological Survey; Indiana from Indiana Division of Geology; Missouri from Missouri Geological Survey; Tennessee from Tennessee Division of Geology; Bradford, Kane-Clarendon, and Allegany fields of Pennsylvania and New York from *Producers' Monthly.*)

STATE OR DISTRICT	MONTHLY COMPLETIONS, OCTOBER, 1947 — NEW WELLS: Oil	Dist.	Gas	Dry	Water Input	Gas Input	Water Disposal	Total New	Total Drilled Deeper	TOTAL COMPLETIONS: Oct., 1947	Sept., 1947	Oct., 1946	Footage October, 1947	CUMULATIVE TOTAL January-October: Wells 1947	Wells 1946	Percent Diff.	Footage 1947	Rigs in Operation (Drilling, Rigging Up and Shut Down): Oct. 31, 1947	Sept. 30, 1947	Oct. 31, 1946
Alabama				4				4		4	5	1	19,768	23	14	+ 64.3	91,561	6	4	10
Arizona												1			2	—100.0				
Arkansas	24		2	21				47		47	27	15	182,351	262	157	+ 66.9	1,065,057	37	48	33
California	157		3	34				194		194	185	164	712,709	1,609	1,587	+ 1.4	6,648,453	273	270	285
Colorado	18		1	3				22	1	23	24	16	125,474	169	135	+ 25.2	921,004	72	74	65
Florida	1			2				3		3	2	1	22,299	27	22	+ 22.7	145,890	5	4	8
Georgia														3	2	+ 50.0	11,945	1	1	
Illinois	95		1	95				191		191	202	215	431,643	1,692	1,951	— 13.3	4,268,060	229	211	260
Indiana	24		2	22				48		48	68	57	79,525	479	431	+ 11.1	852,229	79	81	66
Iowa																				1
Kansas	135		78	102			4	319		319	235	196	1,034,082	2,174	1,810	+ 20.1	6,860,039	348	384	290
Kentucky	22		24	21				67		67	73	73	145,942	710	711	— 0.1	1,343,097	99	110	114
Louisiana	113	13	12	49			1	188		188	153	135	894,408	1,321	1,173	+ 12.6	7,081,043	198	194	161
North Louisiana	82	5	12	34			1	134		134	105	79	384,789	800	670	+ 19.4	2,416,760	76	81	76
South Louisiana	31	8		15				54		54	48	56	509,619	521	503	+ 3.6	4,664,283	122	113	85
Michigan	33		5	45				83		83	73	71	186,016	581	674	— 13.8	1,340,416	133	135	108
Mississippi	36	2	3	13				54		54	41	28	428,409	398	202	+ 97.0	3,353,497	69	75	67
Missouri	1			6				7		7		2	6,559	35	24	+ 45.8	19,668	6	6	2
Montana	15		5	10				30		30	27	26	64,244	187	231	— 19.0	432,345	77	66	61
Nebraska											2			3	3		7,987	4	4	4
New Mexico	24		8	9				41	3	44	46	37	170,354	479	384	+ 24.7	1,967,241	124	122	99
New York	103			1	81			185		185	161	[5]86	260,990	1,527	[5]972	[5]+ 57.1	2,160,817	[5]228	[5]216	107
North Carolina														1	1		6,370			
Ohio	40		49	39				128	3	131	105	153	352,504	1,117	1,110	+ 0.6	3,141,219	262	252	258
Oklahoma	152	1	22	114		1	2	292	4	296	348	398	1,002,654	3,083	2,663	+ 15.8	9,306,425	506	523	514
Oregon														1	2	— 50.0	8,500			
Pennsylvania	126		47	16	111	22		322	7	329	331	[5]319	566,606	2,902	[5]3,500	[5]— 17.1	5,014,945	[5]421	[5]440	313
South Dakota															1	100.0		1	1	3
Tennessee														13	2	+550.0	18,446	11	11	
Texas	514	13	36	320				883	29	912	790	690	3,917,295	7,873	7,050	+ 11.7	33,526,217	1,247	1,294	1,139
Dist. 1—S. Central	25			34				59	1	60	31	16	199,975	304	148	+105.4	1,073,494	49	43	28
Dist. 2—Middle Gulf	33	3	3	19				58	1	59	47	[1]	332,954	527	[1]	[1]	3,177,845	68	55	[1]
Dist. 3—Upper Gulf	57	3	4	30				94	1	95	78	58	601,930	721	572	+ 26.0	4,590,567	112	123	85
Dist. 4—L. Gulf-S.W.	51	3	4	50				108	5	113	90	127	575,497	938	1,333	+ 9.9	4,957,914	119	113	137
Dist. 5—E. Central	10	1		12				23		23	18	[2]	87,472	137	[2]	[2]	664,389	28	29	[2]
Dist. 6—Northeast	30		8	17				55		55	34	62	276,529	416	618	— 10.5	2,121,240	69	73	93
Dist. 7-B—N. Central	28	1	5	51				85	3	88	84	[3]	270,964	746	[3]	[3]	2,266,668	106	130	[3]
Dist. 7-C—W. Central	18			3				21	3	24	36	[4]	74,348	232	[4]	[4]	765,955	54	54	[4]
Dist. 8—West	151			23				174	9	183	174	172	878,027	1,649	1,535	+ 22.5	7,820,237	422	439	430
Dist. 9—North	79	2		74				155	6	161	150	237	429,356	1,781	2,535	— 0.3	4,616,532	100	104	276
Dist. 10—Panhandle	32		12	7				51		51	48	18	190,243	422	309	+ 36.6	1,471,376	120	131	90
Utah												1		3	5	— 40.0	14,143	12	9	7
Virginia															2	—100.0				
Washington				1				1		1			11,002	1	1		11,002	1	2	
West Virginia	16		39	18				73		73	79	74	201,490	719	666	+ 8.0	1,938,359	365	356	426
Wyoming	20		3	11				34	3	37	28	16	166,005	210	136	+ 54.4	969,403	82	86	58
Total United States	1,669	29	340	956	192	23	7	3,216	50	3,266	3,005	2,775	10,982,329	27,602	25,624	+ 7.7	92,525,378	4,896	4,979	4,459

[1] Dist. 2 included with Dist. 4. [2] Dist. 5 included with Dist. 6. [3] Dist. 7-B included with Dist. 9. [4] Dist. 7-C included with Dist. 8. [5] Part of Bradford field now included in New York; formerly, all was carried in Pennsylvania.

Economic Trends

IN CONTRACT DRILLING

By J. E. WARREN
Carl B. King Drilling Company

CYCLIC operation of the drilling industry, with alternating periods of profitable operation and of rehabilitation following liquidation, renders a study of the economics highly necessary. The author reviews basic principles and draws important conclusions.

THOSE in the petroleum industry can take pride in the remarkable progress made in the science of discovery, efficient and conservative production, and the highly specialized techniques in refining oil. Similarly, those employed in the drilling business can be proud of the progress made in the art of drilling wells. Improved drilling practices and design of equipment with greated efficiency and increased capacity, together with increased proficiency of supervisors, engineers, drillers and crews, are real and substantial contributions to the petroleum industry.

There are more rotary drilling rigs operating today, drilling a greater amount of footage, than at any other time in the history of the petroleum industry. Authorities concur in their beliefs that a high rate of drilling must be maintained in order to provide a sufficient number of wells to meet the nation's need for petroleum. In fact, the volume of steel tubular goods made available to the industry will control and limit the rate of drilling into the unforeseeable future. The need for more and more drilled wells makes it important that operators correctly appraise the trends and understand the basic fundamentals that affect the efficient and economic drilling of wells.

* Paper for presentation before a Division of Production group session on drilling and production practice before the 27th annual meeting of the API, at Chicago, November 11, 1947.

The art of drilling wells constitutes an important and specialized part of the oil business. Most drilling operations can be more effectively managed by independent contractors. Because they have greater independence of action, they can distribute their services to more than one company. They have specialized experience and knowledge, and they are ever vigilant and alert toward promoting economies because of the inducements of the profit incentives and the strongly competitive nature of the business. The high percentage of wells being drilled by independent drilling contractors is ample proof of the essential position they now occupy in the industry. According to a recent and reliable survey, 82 percent of the rotary rigs actually drilling hole are owned and operated by independent drilling contractors. The remaining 18 percent of the total active rigs belong to oil companies who operate them in drilling their own wells. Approximately 500 contracting firms that are stable in character are engaged in the rotary drilling business. They range in size from one--rig owners to drilling companies who operate businesses worth several million dollars.

It is axiomatic that oil companies employ contractors only because they believe that greater benefits will result, when all factors are considered, than if they drilled all their wells with company owned and operated tools. The money paid for drilling wells ultimately must come from oil produced and marketed to the public and the industry eventually absorbs any of the mistakes and inefficiencies that may result from drilling operations, and likewise receives the benefits which accrue from the employment of new and more efficient methods and equipment.

Drilling contractors, in order to continue holding an important place in the petroleum industry, must render a valuable and progressive service. To assure that maximum benefits will result from the services of drilling contractors, it is important that underlying principles and trends affecting the contractor's business and factors concerning the company-contractor relationship be fully understood.

What are the trends and basic elements in the drilling business that have a bearing on the cost of drilling wells in the future? To properly understand and discuss this question it is desirable to consider the problem from two points of view. First, the specific trends which are the result of a combination of spe-

About the Author

J. E. WARREN received a B.S. degree from the University of Michigan in 1923, after which he was with The Carter Oil Company two years and the U. S. Bureau of Mines one year. In 1926 he joined Continental Oil Company and remained until 1934, when he went with Carl B. King Drilling Company, of which he is now president.

J. E. Warren

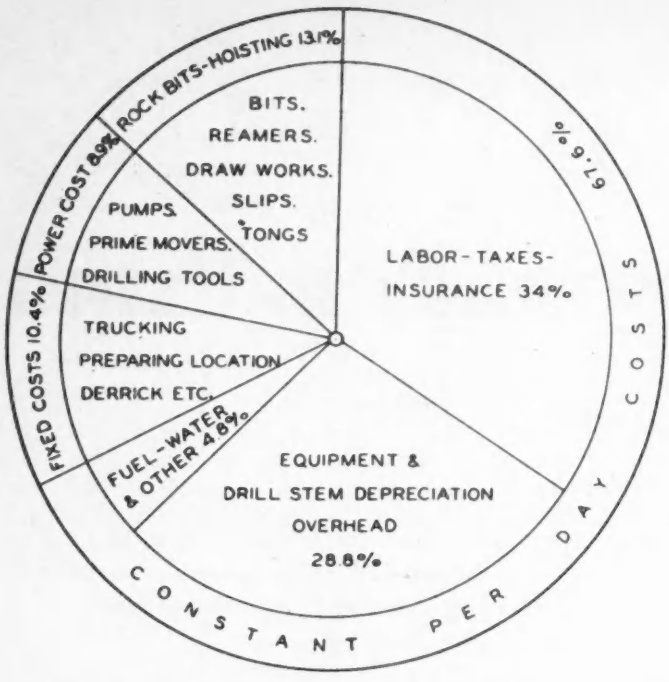

FIGURE 1. Percentage analysis of drilling costs.

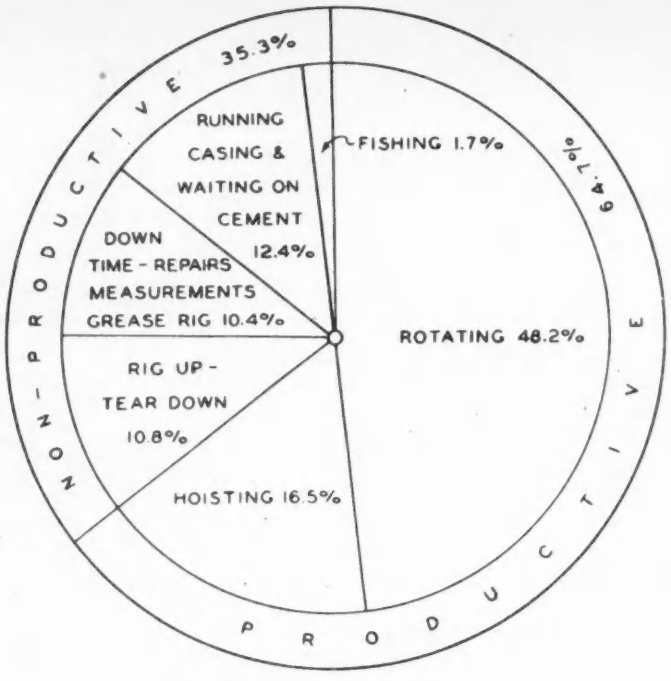

FIGURE 2. Percentage analysis of drilling time.

cific factors such as prices, costs and efficiency. Second, the general trends that are dependent partly on the general course of the oil industry but which also are influenced to a large extent by changes and circumstances within the drilling business itself. Let us look into the specific trends that influence the drilling business today.

Specific Trends

While the fundamental operations employed in drilling wells are the same everywhere, they vary in relative importance, depending on the difference in conditions that exist between locations, formations, and drilling depths. The analysis of statistical data concerning drilling operations, as in all complex practices, must be adjudged and valued on the basis of experience and intimate knowledge of the controlling conditions. The examples used are based on experiences in drilling West Texas wells but the conclusions are of general application providing proper values are given to the variables involved.

Evaluation of operational factors: In order to properly evaluate the various factors, it is essential that the major operations be analyzed from the standpoint of cost and time.

Figure 1 illustrates the relative importance of costs involving depreciation, overhead and labor, which are directly proportional to the elapsed time on a given operation. It also shows those costs that are fixed regardless of the drilling time and those costs that are partly based on time and partly due to intensity of service.

Figure 2 shows the percentage of total time employed in actual drilling operations compared to the time consumed in preparing to drill and performing other essential operations.

These charts are shown in order that the observer can consider and appreciate the relative importance of each functional operation in the drilling of wells, from the standpoint of both cost and time.

The cost factor: Rotary drilling equipment, labor, and materials have substantially increased in cost in the last few years. A rotary drilling rig, complete with drill pipe of sufficient capacity to efficiently drill wells deeper than 9000 feet in West Texas which cost $217,000 in 1943, has increased in price to $284,000 today. This represents an increase of 31.2 percent in the weighted average price of capital equipment used in rotary drilling operations. In order to attain the maximum efficiency gained through improved methods, an additional $40,000 in drill collars and equipment would be added to the cost of this typical rig making the total cost $324,000 if purchased today. In addition to the 31.2 percent average increase in price, there is an increase of 18.1 percent to gain added efficiency, making the total increase 49.3 percent. These increases are graphically illustrated in Figure 3.

The costs of all items of expense have increased proportionately. Figure 4 shows the cost of a typical well in 1944 expanded to what this same well would cost today. These figures are based on 1944 experience and do not allow for increased efficiencies developed since that time.

The trend in costs is still rising, and is common to all areas of development and types of drilling operations.

Increased efficiency: The average rotary drilling rig in the U. S. is drilling approximately 25 percent more hole per day now than it was at the start of the wartime demand for drilling and 20 percent more than in 1945 when rotary drilling was at its wartime peak. Part of this increase can be attributed directly to the return of experienced and efficient workmen from the war and the remainder to the employment of efficient equipment and development of improved drilling methods. Drilling equipment throughout the industry is more up-to-date, more efficient, and better maintained than at any other previous period in the history of the drilling business.

The time factor: Many of the costs necessary to drilling wells are directly related to the length of time required to complete the operation. The time factor is so important that erroneous comparisons are often made on the basis that the overall costs of drilling are directly proportional to drilling time.

Those engaged in the drilling business are constantly analyzing their operations and altering drilling procedures in an effort to reduce the number of days required for drilling wells. The primary purpose of drilling is to "make hole" and hole is only "made" efficiently when the bit is on bottom a maximum amount of time, drilling at its most productive rate.

Cost per operating day: It is impossible for a contractor to make an intelligent bid on drilling certain types of formations because of unpredictable variations in drilling characteristics and in some instances because of unusual hazards.

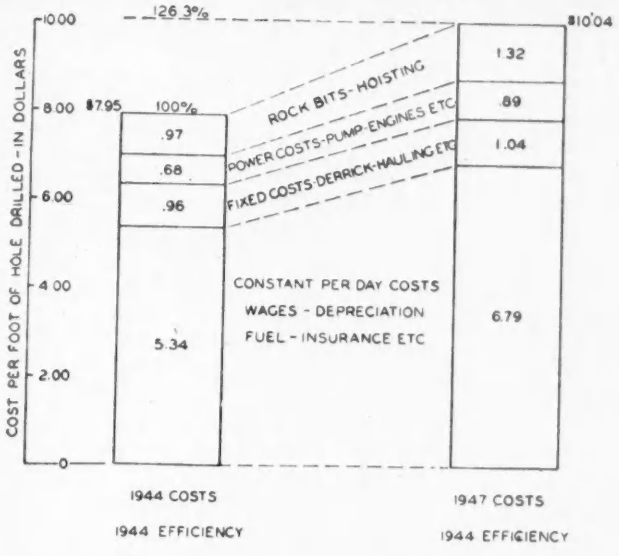

FIGURE 3. Increase of operating costs. Due to increases in prices labor, material, etc., typical 1944 well costs expanded to 1947 prices of material, labor, etc.

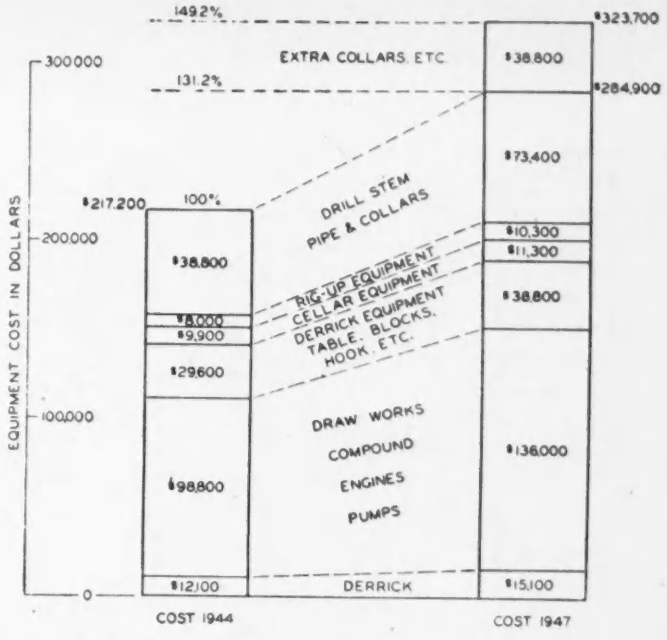

FIGURE 4. Comparison of capital investment in a heavy West Texas rig.

The practice is to pay a specified daywork rate to contractors for services performed under these conditions. Dayworks rates also are paid for testing, coring, electrical surveys, etc. Since daywork constitutes an important item in drilling wells, it is advisable to show the elements of cost involved in this type of work.

Figure 5 shows the relation of cost per day compared to the number of drilling days for a given set of conditions. The trend of operating costs per day compared to the number of drilling days per well is clearly shown. Cost per day vs. days per well is illustrated in two ways. First, the cost trend if all prices of materials, labor, equipment, etc., were stabilized at the current level. Second, the cost trend as it has actually developed since 1944, including the increases in prices of materials, etc., that have occurred since that time.

It can be seen that the cost per day increases more rapidly as fewer and fewer days are required for drilling wells. This is an important point in considering daywork rates as it puts a premium on inefficiency and a penalty on outstanding performance. Daywork rates should be devised to offer an incentive for increased efficiency.

Cost per foot: The cost per foot is of paramount importance as it is directly related to the revenue received by the contractor and represents the cost to the company for drilling services.

Figure 6 shows the cost per foot of hole drilled using the information developed in Figure 4 and using 6700 feet as the average depth of the wells considered.

It can be readily seen that an increase in efficiency resulting in fewer drilling days has a decided bearing on the cost per foot of hole drilled. The relationship between drilling days and cost per foot is not constant and there is a point where further reduction in drilling time will not result in reducing the cost per foot. This condition can be altered only by a fundamental improvement in drilling methods.

General Trends

The historical trend of the drilling business has been cyclic in character. A

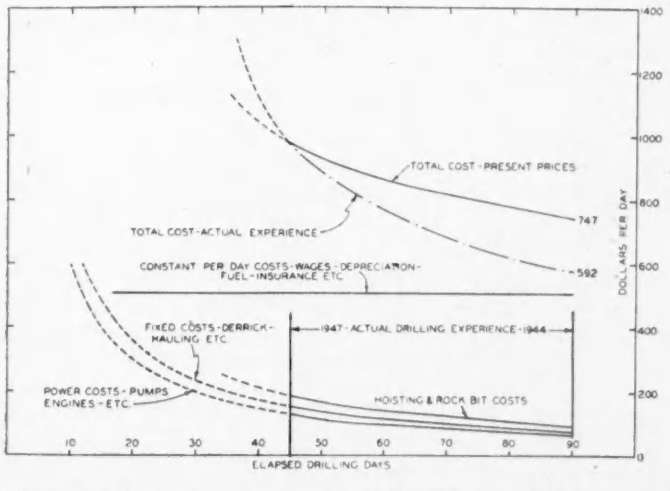

FIGURE 5. Relation of cost per day to total drilling time. (Based on experience of wells drilled during 1944-47. Average depth 6700 feet, West Texas.)

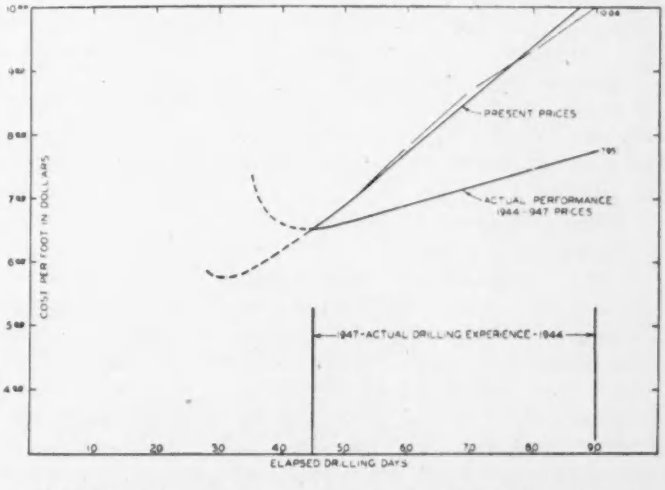

FIGURE 6. Relation of cost per foot to total drilling time. (Based on experience of wells drilled during 1944-47. Average depth, 6700 feet, West Texas.)

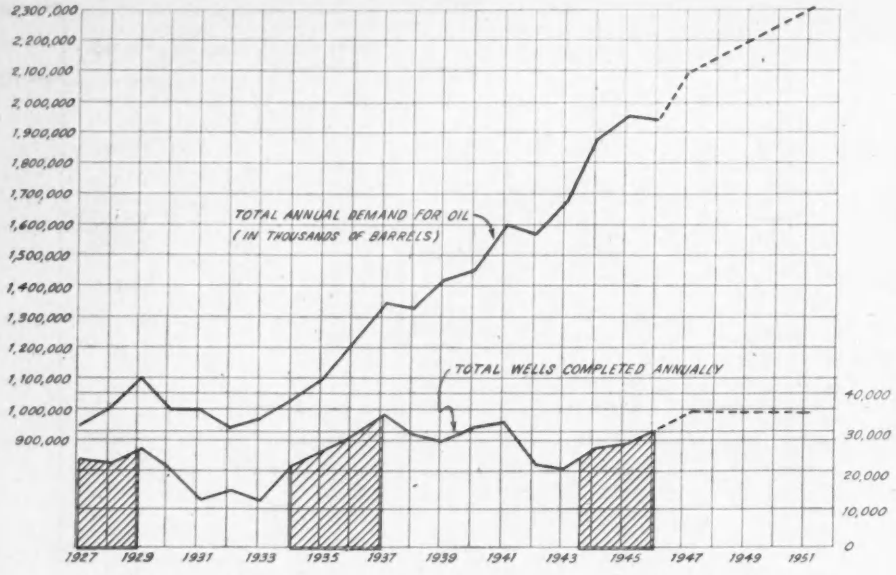

FIGURE 7. Total demand for oil and total wells completed in the U. S. by years.

cycle begins with a period of acquisition and progress and ends with a period of liquidation and stagnation.

The large investments necessary to drill wells today must be amortized over several years. They are possible only when there is an incentive of unusual profits or the prospect of lasting stability in the business. The drilling business has been characterically unstable throughout its history and it is the incentive of unusual profits that periodically attracts capital into the drilling contracting business.

When the demand for drilling wells exceeds the available supply of efficient drilling equipment, sufficient profit incentives are developed to attract new and additional capital into the business. During this period of high profits, acquisitions of new and efficient equipment are made, better equipment designed, and improved drilling methods are practiced. The increased efficiency resulting from improved equipment and methods progresses until the business is in a state of over-expansion. This oversupply of drilling rigs marks the beginning of a period of liquidation and stagnation.

When drilling rigs are in over-supply, intense competition results and drilling prices are reduced to a minimum. Wells are then drilled at or below the margins necessary for depreciation and overhead. The inevitable result is liquidation of physical assets into cash, and equipment becomes obsolete and worn out. We have experienced two complete cycles of this character in the last twenty years, and are now in the middle point of the third one. To illustrate these cycles, Figure 7 was prepared showing the number of wells completed, and the total demand for oil in the U. S. by years. Periods of acquisition and progress occurred from 1926 through 1929, from 1934 through 1937, and from July, 1943, through 1946; these periods are crosshatched on the chart. Periods of liquidation and stagnation occurred from 1930 through 1933, from 1938 through June, 1943, and the last part of 1947. The length of each period is approximately four years, and the complete cycle about eight years.

The current cycle began when the war demand for drilling started in the middle of 1943. The drilling industry was at that time in a depleted condition in both personnel and equipment. Drilling was held at a minimum in 1942, and the first half of 1943, and experienced drillers and roughnecks were attracted to the war industries, or into the armed services. It was, therefore, necessary to create profit incentives that would make it possible for contractors to operate with inefficient and inexperienced labor, and rehabilitate and purchase modern and efficient equipment.

New drilling rigs were purchased and improvements in drilling methods continued to develop until 1946. The supply of drilling rigs again exceeded the industry's demand for drilled wells and the resulting competition between contractors forced a sharp reduction in the price of drilling. The return of efficient and experienced workmen to the drilling business and the employment of modern equipment and improved methods resulted in reducing drilling costs sufficiently to compensate for the reduction in drilling prices. The increased costs of equipment, materials, and labor are now exceeding the savings made in operating costs realized through increased efficiency.

Conclusions

The excessive fluctuations that make up the typical drilling business cycle are uneconomic and expensive to the petroleum industry. The price of the periodic rehabilitation of the drilling industry and the real but intangible losses that occur during periods of liquidation is a substantial one. Anything accomplished that will lend a measure of stability but maintain healthy and progressive competition will be a real and economic gain to the petroleum industry as a whole. Oil companies strive to reduce their drilling costs to a minimum, which is a natural consequence of good business management.

Immediate gains, however, that are obtained by the reduction of drilling prices below costs will be wiped out by future losses that this uneconomic condition will create.

Oil companies and drilling contractors alike will receive maximum benefit from their business relations if the basic economic principles of contract drilling are studied and evaluated in a realistic manner.

Reviewing the trends that are now developing in the drilling business, we reach the following conclusions.

1. The limiting factor created by an insufficient supply of oil country tubular goods does and will continue to control the rate at which wells will be drilled into the unpredictable future. This condition creates a ceiling on the rate of drilling at a level where drilling rigs are in competitive supply.

2. The costs of labor, material and capital equipment have increased tremendously, and at the same time revenue from drilling has dropped to a point at which many contractors are again operating on depreciation and overhead margins.

3. If these conditions continue, the efficient state of the drilling business which now exists will deteriorate and unusual profit incentives will again be necessary to attract needed capital, and drilling prices will rise accordingly.

It behooves company and contractor alike to give serious consideration to the present state of the drilling business. The current rate of drilling is going forward at a cost to the petroleum industry of roughly $500 million per year. This cost must be continued into the unpredictable future if the industry's need for drilled wells is met. It is therefore important that the drilling industry maintain a high level of efficiency and that each problem and condition that affects efficiency be recognized and met in a realistic manner.

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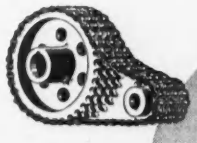

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Taking off from its Houston base, this plane will land in Hobbs, N. M., in about four hours, delivering fishing tools to a waiting rig. At slightly higher cost than highway deliveries, hours of expensive shutdown time are saved by airplanes.

ADVENT of the airplane into oil field hauling operations is saving drilling contractors, oil companies, and equipment manufacturers countless dollars in rushing replacement parts to rigs with mechanical failure. Numerous companies engaged in drilling activities, as well as manufacturers and specialty companies who service rigs, now own airplanes which are dispatched to a breakdown with the required parts, sometimes carrying a skilled mechanic who repairs the trouble while the airplane waits.

The oil industry now regards airplanes as a useful and essential carrier, not only as a deluxe mode of transportation for company executives and visiting big-wigs, but also for routine oil field services including the hauling of equipment. Delivery of parts and supplies directly to rigs in the field formerly was regarded as a job for surface types of transport, such as trucks, pickups, or company cars. With the lifting of wartime flight restrictions, it has been found that deliveries can frequently be made either directly to a rig in the field or to the nearest airport in a fraction of the time formerly required, and at a comparable cost per mile.

Of marked value to the industry is the use of either amphibious aircraft or seaplanes for hauling equipment into marine oil prospects on the Gulf Coast. With a large percentage of South Louisiana oil operations situated in the waters of open bays, lakes, or in canals dredged through the swamps, hours of critical time formerly wasted awaiting lengthy highways hauls followed by tedious boat trips to the field are now eliminated. Planes adapted for water landings now set down with a load of repaid parts or personnel near a waiting rig and taxi directly to the drilling barge for unloading.

Many aviation companies, of which Airflite, Inc., of Houston is probably the pioneer, offer a special service to the oil industry in providing fast, direct flights from administrative centers to widely scattered oil fields including marine drilling areas. Operating planes from Houston, manufacturing and supply center for a vast oil-producing region, company planes have made scores of flights during the past year, landing near oil fields in nearly all sections of the Southwest and Mid-Continent area, at times delivering parts in 24 to 48 hours less time than is possible with the fastest surface transportation.

Heavy Loads and Light

The size and weight of most oil field equipment once seemed a formidable obstacle for air hauling, and many items in field use are of such weight and bulk as to make air deliveries impracticable. However, records show that for a period exceeding a year, and carrying equipment of many and diverse types, average loads have weighed only around 100 to 150 pounds, although weights several times this figure are carried easily. The lightest load delivered thus far weighed only a few ounces—two special flashlight globes, flown 840 miles!

During a single fishing job on the world's deepest test drilled last spring in western Oklahoma, nine trips were made from Houston during a 12-day period, each time loaded with parts needed to continue the operation. Immediately upon retrieving a portion of the fish, and while still pulling pipe from the hole, the office of the Houston firm conducting the fishing job was contacted by telephone and instructed to send a tool of a different type needed for continuing the fishing operation. The tool, rushed to the airport and delivered to a waiting plane, was landed about 420 air miles distant three hours later, often in a pasture adjacent to the rig, while the pipe still was being removed from the hole.

Biggest benefits of air deliveries are gained by oil companies and drilling contractors operating in the marine fields of Louisiana. On a typical trip, the plane leaves its airport in Houston, and settles a little over three hours

Bags of cuttings placed in an airplane at High Island, Texas, will reach Houston 30 minutes later for analysis by the company geologist, who formerly "sat" on a well to accomplish the same task.

later in the waters of the Venice La., oil field. This trip supplants a 450-mile highway ride, followed by a boat trip of an hour or more. The time saved by use of the airplane on this trip ranges between seven and nine hours, which represents the time saved on an average trip. With greater distance to cover, the saving of rig shutdown time becomes increasingly greater.

Past records of "hot-shot" flights too numerous to mention show many instances, as in the Venice example described above, where planes have delivered equipment, airport-to-airport, or airport-to-rig, into remote drilling areas where ordinary highway-boat travel requires many hours longer. While in man cases, savings to the drilling contractor cannot be calculated, as in threatened blowouts or stuck drill pipe, even in routine flights the savings are sometimes considerable. Frequently, elated tool pushers meet arriving airplanes with the exclamation, "You folks have saved my company $500," refering only to the reduction in rig shutdown time.

Several oil companies in Houston have taken advantage of another unique use of airplanes, namely, flying cuttings or cores from the field into Houston daily for analysis. To the geologist who formerly drove his car to the field each day or "sat" on a well during critical drilling depths, this service presents a bonus in both time and effort, enabling him to remain in his office to care for other work while at the same time keeping a close watch on the progress of several drilling wells instead of limiting his attention to a single well. From the company standpoint, the cost of securing the airborne cuttings is usually no more than the cost of driving a car after them, while the advantages of having the geologist or other trained personnel in the office rather than on the highway are obvious.

Weather Problem

Weather, the nemesis of all air transportation, presents aerial "hot-shots" their greatest problem. However, in the Southwest, with the exception of January and February, weather as a whole is favorable for flying. A combination of weather "luck" and pilot skill has helped to compile an enviable record of "jobs completed."

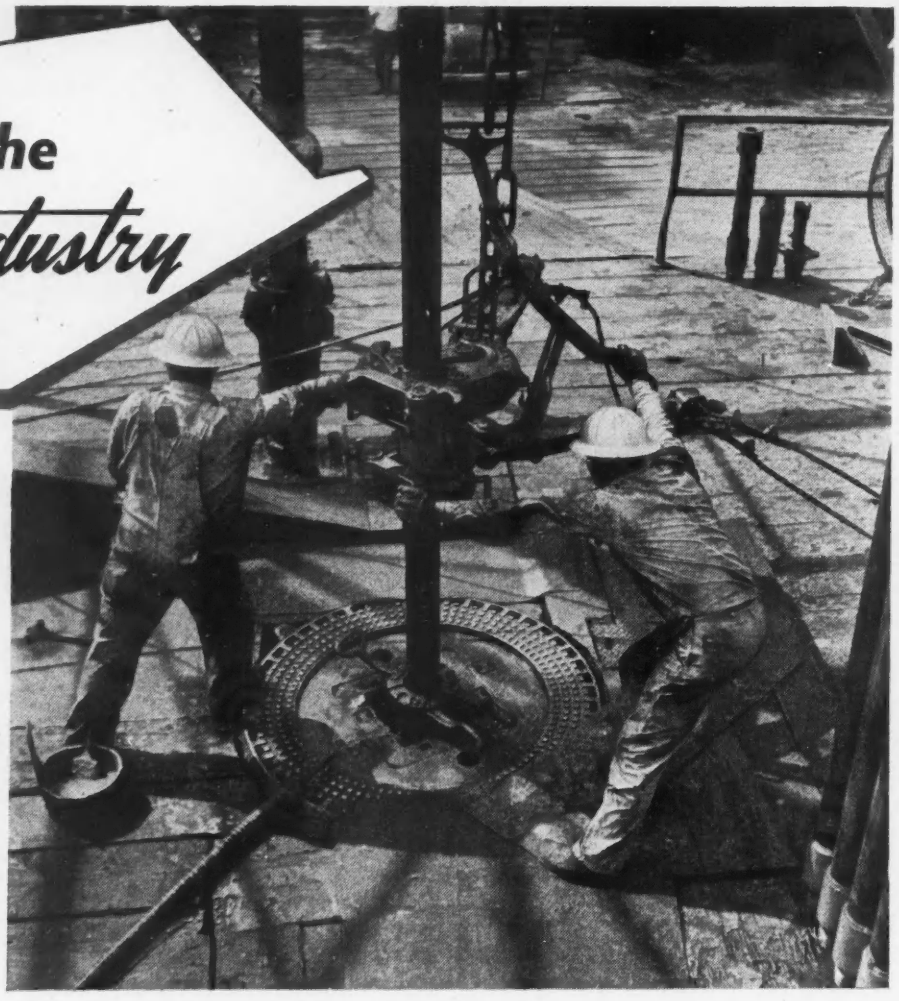
In fact, company records show that 100 percent of the equipment entrusted to one flying service company's pilots reached its destination, although not always in the manner intended. There was the time when a plane was forced down in Oklahoma by heavy snowstorms, landing in a snow-covered pasture which fortunately was only two miles from the rig. Also, with good fortune, the load weighed only five pounds. The pilot placed the box under his arm and trudged through deep snowdrifts to the site of the well.

Another arduous winter trip took a plane to West Texas. With ice forming on the control surfaces and thick on other portions of the plane, the pilot landed in San Angelo, 100 miles from his goal. Not to be stopped in completing his assignment, the pilot boarded the first bus, and although delayed, reached his destination in ample time.

Weather in general has been kind to planes and pilots trying to reach remote rigs in time to be of service, with most trouble being encountered on the return trip to Houston, after equipment had already been delivered. For instance, last January after a short trip from Houston to Longview, Texas, which required little more than an hour, lowering clouds forced the pilot to remain for four days before starting his return trip. One hour to reach the rig, four days to return!

The oil industry, famed for the speculative spirit which put it in its present position, is ever receptive to new ideas for self-improvement. Skeptical at first about delivery of parts to rigs, but quick to realize the value to be derived from such a service, the oil man was a ready listener and, after the first delivery in this manner, an enthusiastc repeater for the service. Numerus supply companies now fly supplies to the field regardless of the urgency involved, thus establishing better customer relations by their desire to furnish improved services. In the past year, both oil and aviation have benefited through the development of air services heretofore unavailable, creating increased confidence in air delivery and more dependability on aviation as a useful oil field function.

PROGRESS of the Drilling Industry



by

C. W. ALCORN
Falcon-Seaboard
Drilling Company, Houston

SINCE THE Drake discovery at Titusville, the drilling industry has made continuous progress. The "popcorn" rig has been replaced by giant power plants and engineered structures. New equipment and techniques meet the requirements of progressively deeper wells.

IN THE business of producing oil and gas, the first requirement is to get a hole in the ground down to the producing horizon and case the well so that fluids may be brought to the surface. Therefore, drilling may be considered to hold first place in the general business of producing oil and gas. Since it first became desirable to drill holes in the ground to produce oil and gas, there has been extensive experimental work done on drilling equipment and methods. So much of the operation is underneath the ground that actual research work has been limited insofar as above-ground study is concerned to simulated conditions. In refining and production of lighter hydrocarbons, research work has been done in the laboratory and pilot plants where observations are more readily transferred to paper.

The equipment manufacturers, as well as many oil companies, have done experimental work and have collaborated among themselves and with contractors on investigations involving equipment and techniques in drilling operations. In this respect, necessity has been the mother of invention. As greater requirements have been placed on equipment for deeper drilling, hard-rock drilling, high pressures, etc., men of the industry engaged in manufacturing and in actual drilling have come up with the necessary equipment and technique to meet these requirements.

Based on a talk given before the Houston Chapter, API, September 23, 1947.

Development Slow in Beginning

A review of early drilling equipment raises the question of why, after the principle of rotary drilling was generally known, mechanical engineers did not visualize machinery much more efficient than the little "pop-corn" rigs that were in general use for ten years after the turn of the century and even much later. A probable answer is that the human mind in the realm of mechanics, except for some outstanding discoveries and inventions such as the cotton gin, has not shown itself generally capable of more than gradual improvements.

In the early history of the oil-producing business, wells were drilled by cable tool methods, and at first glance, the opinion is formed that practically no improvements have been made in cable tools since the beginning. That is not true. There is a vast difference in tools and equipment used in cable tool drilling at the time of the Drake discovery and for many years thereafter, and present cable tool outfits. True, the difference is mainly through larger rigs.

Steel bull wheels made to accommodate four bull ropes, roller bearing crown blocks, steel calf wheels, bronze bushed steel pittmans, steel walking beams, multi-cylinder internal combustion engines, wire lines, roller-bearing chain-driven sand reels, steel derricks, etc., now constitute the modern cable tool rig. During World War I, the complete standard rig and derrick was made of wood except for rig irons used where bearings were required. One different mechanical means of getting cable tool motion was developed from the standard rig spudding operation in the 1920's, when the machine commonly known as the spudder was invented. This method permitted the machinery and derrick to be combined in one unit and reduced the cost of moving as well as speeded the operation of raising and lowering tools in the hole. There were other portable cable tool machinery, but still the beam method of the standard rig was employed, and therefore, had to be built

neavier and more cumbersome than the spudding machine. There is still a definite place for cable tools in the drilling industry. They are often used for shallow wells in hard rock areas, as for example, in West Viginia holes less than 6000 feet in depth can be drilled more cheaply with cable tools than with the rotary. It is surprising that of the 30,221 holes of all kinds drilled for oil, gas or salt water disposal in the U. S. during 1946, 36½ percent were drilled with cable tools.

The Rotary Rig

The rotary machine was first used in the 1890's, and was credited with drilling its first oil well near Corsicana. Rotary motion of the drill pipe there was obtained with a sweep and one mule for power.

Drilling depths in the U. S. vary from a few hundred feet to well below 12,000 feet, and the equipment industry builds modern tools to fit these varying depths. The fact that special equipment is designed for these varying depths indicates that it is most economical to use a rig to fit the depth. One large company is carrying on an experiment designed to test this economic theory. In a field where many wells have been drilled to approximately 6800 feet using the size and type equipment generally considered adequate for efficient, economic drilling to that depth, two locations were selected for the experiment.

On one location, crews moved in a rig capable of drilling a 15,000-foot hole, employed nine drill collars and used pump principles designed to make full use of all of the horsepower in the rig. The hole was made in two drilling days by this large rig. On the second location was erected a rig of a size that had been regularly employed on that depth well. With this rig, the hole was drilled in eight drilling days. In this field, it had been taking approximately 30 days to drill and complete a 6800-foot well because of the completion methods necessary.

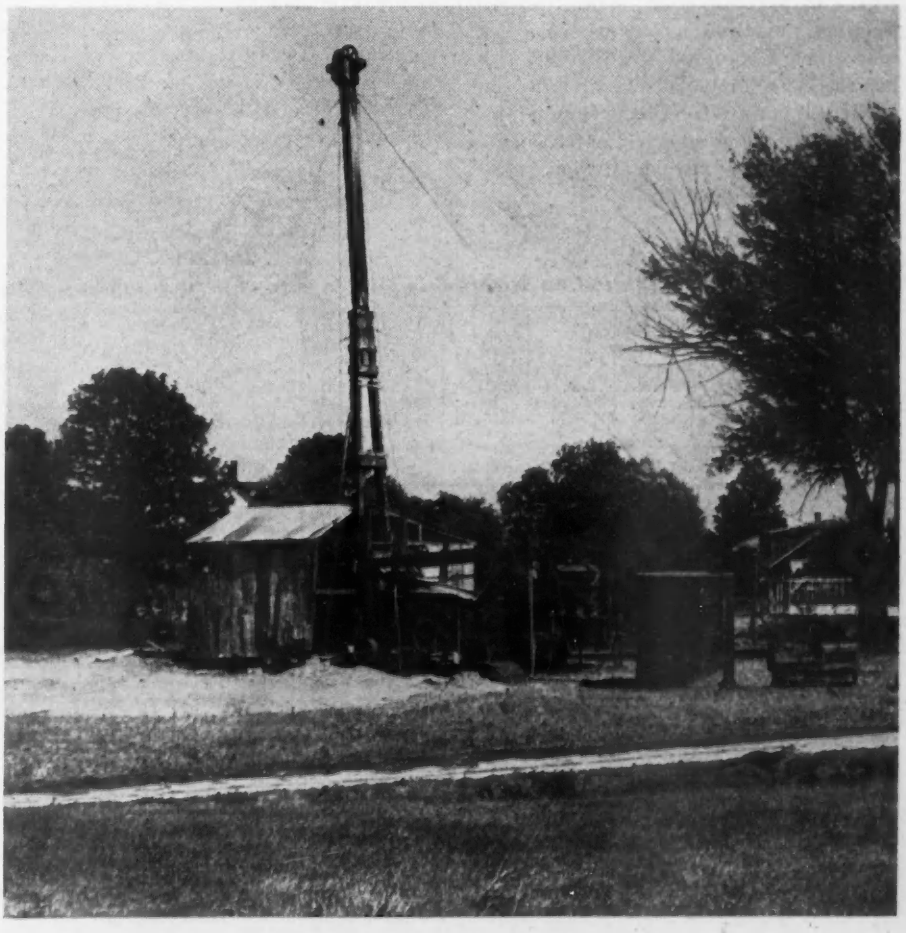
When these two wells are completed, a very detailed cost statement will be made up on both holes, taking into account the difference in depreciation of the two types of rigs, and the final results on the economics will be determined. It will be interesting to know the results, but it is believed that the economics will be in favor of the smaller rig. If the situation were similar to that before proration when line fighting was the general practice and every operator did his best to get the advantage by producing the greatest share possible from the reservoir, modern heavy equipment might be utilized on shallow wells and would be the most favored rig.

Ingenuity and the general advancement of science has brought into the oil business such instruments as the torsion balance, the gravity meter, the seismograph, and soil analysis. These devices provide surface study of oil and gas reservoirs. This means more holes to drill. Over a period of many years, efforts have been made to build machines based on electric and magnetic principles to indicate oil in place. Some manufacturers and operators of such machines claim to have met with success in this development. Successful instruments as aids to geology offer practically limitless possibilities in the search for stratigraphic oil, and there may be much more oil in stratigraphic traps than has been discovered or will be discovered in structural reservoirs in this country.

Other instruments employing electricity have been developed to indicate oil and gas in a drilled hole. The electric log is one example. Mechanical tools have been developed to take cores from formations penetrated both directly from the bottom and the side of the hole. Tools have been developed to make tests of formations to determine the probable productivity of oil or gas before the expense of setting casing in incurred. Laboratories have been equipped for testing cored formations. Some of these have been placed on trucks that go directly to the well. A method of quick-freezing permits the cores to be transported from the well to a distant laboratory without losing any of their original characteristics. All of these methods aid in discovering oil and keeping the drilling rigs turning.

Social Progress

Along with mechanical improvements in drilling, there also has been what is known as social progress. During the first 60 or 70 years in the drilling business, a man worked 12 hours per day and 24-hour operations were carried on in two shifts. In the early 1920's, the practice of using three 8-hour shifts for a 24-hour period came into general use, with crews still working seven days per week. During the New Deal, the 40-hour week was developed. Most drilling crews still operate on a seven-day week and are paid time and a half for all time over 40 hours or five 8-hour days. Some operators allow their men to work only 40 hours a week and employ relief crews to maintain continuous operation. The equipment industry and the producing organizations have, of economic necessity, gone to the 40-hour week. This is social progress, but in an industry that operates on a 24-hour day, seven days a week, problems result that are costing the oil industry a great deal of money in delays. The following is a list of events that can happen on a well during Saturday or Sunday and cause delay



An example of the spudder-type cable tool rig popular in the Appalachian area during the 1930's.

until Monday: (1) running electric log and finding shows; (2) taking sidewall cores or regular cores and finding shows; (3) failure in a completion procedure; (4) failure of some equipment; and (5) development of a need for some special equipment.

While it is not impossible to get shop work and transporting done, special equipment delivered, decisions from the boss, etc., the process of getting it over the weekend has definitely been slowed. While the practice may be desirable, the 40-hour week has added to drilling costs.

Transportation

One of the first items to be considered in actual drilling operations is transportation of equipment. Transportation has developed along with the need, and today it can be employed in the movement of drilling equipment in a very efficient manner. The next problem is rigging up and tearing down a drilling rig. One large company has developed procedures for transportation, rigging up and tearing down to a very high degree by standardizing location layout to fit the rig to be used on it. Also by adopting a unitization plan of the complete rig and organizing their own transportation, it is possible to have one truck make only one load of a rig. Transportation crews are trained to know exactly where to put that load on the location. Such organization makes it possible to tear down a complete drilling rig of the largest type, move it several miles and set it up again within a 24-hour period. To do this, a number of extra men in addition to the regular drilling crews are used in rigging up.

Several difficulties are presented to the contractor in developing this efficiency. He often is required by different companies to set up his rig in different ways. Therefore, he is not able to employ the unitization plan to the degree mentioned above. Also, it is of considerable expense to unitize and equip a rig to meet the fastest rigging-up and tearing-down requirements. Especially is this true of a rig already rigged up and operating with only the usual amount of unitization. In putting a new rig together, it could be engineered for unitization without unreasonable additional cost. But here again, this most often is not done because of the lack of planning personnel. Therefore, drilling equipment is rigged up, unitized and equipped with almost as many different ideas as there are drilling companies in the business.

A tremendous cost in drilling is chargeable to transportation, particularly in contract drilling. Contractors in our system of free enterprise roam the length and breadth of this U. S. with their drilling equipment and for various reasons, some often known only to themselves, they are willing to transport rigs long distances to do a job.

Drilling Bit Progress

Actual drilling in the hole has made steady improvement with necessity. Drilling bits of all types, both fish-tail and rock bits, have been improved by continued use of better design, better steel and hard-facing materials as they have developed. From the files of one bit manufacturer came the following data:

"In the period from 1925-1930 average footage per bit increased 79 percent, and average penetration or feet of hole per hour increased 125 percent. It was during this period that the Acme cone bit was developed. In the period 1930-35, average footage per bit increased 12 percent, penetration increased 35 percent. These were the depression years and the depression had its effect on production and development as evidenced by the small increase in the average footage per bit."

In 1933 the three-cone bit was introduced.

"In the period 1935-1940 footage per bit increased 43 percent and speed of penetration 84 percent. It was during this period that considerable refinement of the three-cone bit was made with special designs for various types of formations. Also, much more hard-facing material was used in this period.

"In the period 1940-1947 average footage per bit has increased overall from 25-30 percent. These data are broken down according to different areas. West Texas increased 30 percent, Oklahoma and Kansas 25 percent, and the Gulf Coast 30 percent. The average speed of penetration in this period increased from 30-35 percent. West Texas increased 35 percent; Oklahoma and Kansas 30 percent, and the Gulf Coast (Texas and Louisiana) increase was from 30-35 percent. The West Coast and Rocky Mountain area were not broken down because records of those areas would, to some extent, cloud the issue; the Pacific Coast area being one where extremely light weights and high rotary speeds are used, and the Rocky Mountain area being an area for generally light weights, with the exception of Rangely."

These percentages of increase in foot-

TABLE 1

Effect of Bit Watercourse Size on Rate of Drilling with Drag Bits—Example Well No. 1

Bit No.	No. Watercourses	Size Watercourses in I.D.	Total Area Watercourses Sq. In.	Rate of Circulation G.P.M.	Estimated Pressure Drop Through Bits Lbs. Sq. In.	Feet Drilled	Bit Weight Pounds	Drilling Rate Ft./Hr.
Interval 1—4,312′ to 5,050′								
1	2	5/16	0.614	700	1,095	138	8,000	151
4	2	5/16	0.614	700	1,095	150	8,000	204
3	2	1	1.57	700	250	133	8,000	106
2	2	1 3/16	2.96	700	90	150	8,000	82
5	2	1 3/16	2.96	700	90	150	8,000	63
Interval 2—6,200′ to 6,600′								
9	2	5/16	0.614	630	875	100	8,000	94
7	2	1	1.57	630	195	100	8,000	53
8	2	2 2/16	6.68	630	0	100	8,000	28
9	2	5/16	0.614	630	875	50	14,000	71
7	2	1	1.57	630	195	50	14,000	88
9	2	5/16	0.614	630	875	150 Total Avg.		85
7	2	1	1.57	630	195	150 Total Avg.		61
Interval 3—6,607′ to 7,050′								
12	2	5/16	0.614	630	875	53	4,000	66
10	2	1	1.57	630	195	68	4,000	78
11	2	1 3/16	2.96	603	70	75	4,000	56
12	2	5/16	0.614	630	875	75	8,000	64
10	2	1	1.57	630	195	75	8,000	66
11	2	1 3/16	2.96	630	70	75	8,000	51
12	2	5/16	0.614	630	875	128 Total Avg.		64
10	2	1	1.57	630	195	143 Total Avg.		72
11	2	1 3/16	2.96	630	70	150 Total Avg.		53

Effect of Bit Watercourse Size and Distribution of Fluid on Rate of Drilling with Drag Bits—Example Well No. 2

Bit No.	No. Watercourses	Size Watercourses in I.D.	Total Area Watercourses Sq. In.	Rate of Circulation G.P.M.	Estimated Pressure Drop Through Bits Lbs. Sq. In.	Feet Drilled	Bit Weight Pounds	Drilling Rate Ft./Hr.
Interval 1—5,000′ to 5,293′								
1	2	5/16	0.614	628	1,040	55	10,000	193
3	4	1/2	0.784	628	745	100	10,000	80
5	2	1	1.570	628	200	27	10,000	33
4	4	3/4	1.768	628	180	38	10,000	20
Interval 1—5,366′ to 5,866′								
6	2	5/16	0.614	570	840	100	4,000	182
8	4	1/2	0.784	570	585	100	4-6,000	122
10	2	1	1.570	570	150	100	4-6,000	87
7	4	3/4	1.768	570	145	100	4-6,000	47
9	2	1 1/2	2.960	570	40	100	2-4,000	46

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age and penetration indicate that a remarkable improvement has been made in drilling bits from 1925-1947. All companies producing bits, both rock bits and fish-tail, through improved design and hard-facing, have made outstanding advancements.

Bit Watercourse Studied

To determine the effect of watercourse fluid velocity on the rate of drilling, 22 drag bits with various-sized watercourses were used to drill predetermined intervals of relatively sticky shale formation in Matagorda and Brazoria Counties, Texas. The tests indicated that a trend toward faster drilling was obtained with high pressure drops through watercourses. All bits were 8⅝ inches outside diameter, 5-9/16 inches API box, two and four round watercourses per bit. The minimum watercourse size used was determined by calculating the maximum pressure drop that could be obtained through a bit, with the maximum available horsepower, and still obtain an annular velocity sufficient to remove the cuttings from the hole. Results are shown in Table 1.

The following data show the effect of bit weight on the rate of drilling in Andrews County, Texas.[1]

Well No.	Total Depth	Bit Weight, Pounds	Hours Rotating	Number of Bits Used
1	9052′	8,000	1953	105
2	8880′	20,000	1373	79
3	8945′	24,000	1273	76
4	8946′	32,000	875	69

In a series of tests conducted in the Seeligson field, Kleburg County, Texas, it was found that in general the rate of drilling using drag bits was proportional to the bit weight. In this series of tests the bit weights were varied from 8000 to 32,000 pounds in formations of uniform drillability. Results of the tests are shown in the following table:

Effect of Bit Weight on Drilling Rate in Soft Shale, King Ranch Cabeza 67

Test No.	Weight on Bit, Pounds	Drilling Rate Ft./Hr.
1	8,000	33
1	16,000	103
1	24,000	110
1	32,000	125
2	8,000	21
2	16,000	43
2	24,000	77
3	8,000	21
3	16,000	58
3	24,000	81
3	32,000	120

Rotary speed was maintained at 140 revolutions per minute during all tests. Circulation rate was maintained at 800 gallons per minute during all tests. Information is not available as to what effect the excess weights had on hole deviation.

Diamond drilling bits, for actual drilling at present, do not appear practical. Diamond coring is proving satisfactory and conclusions are as follows:[2]

1. Diamond core drilling has gradually developed into common practice.
2. Diamond coring with the correct diamond bit and a 50-foot core barrel is faster and less expensive than conventional coring or drilling in certain formations.
3. Diamond core bits have been improved until they have a long life and high salvage value if handled carefully.
4. Diamond core bits cut the hole to gauge and eliminate reaming.
5. Core recovery with diamond coring usually is 100 percent.
6. Diamond coring works much better in oil-base mud or water-base oil mud.

In the Rangely field, Colorado, the technique of reverse circulation to pump cores out of the hole has been developed, making it possible to drill many hundreds of feet without removing the drill stem from the hole.

Several companies are working on entirely new and radical methods of operating bits in the hole—a combination percussion and rotary bit. One method provides bit rotation with the drill pipe and percussion action obtained in the design of the drill collar to which the ordinary rock bit is attached. Such experiments indicate that this bit and drill collar combination may be a great improvement for drilling hard formations and especially hard inclined formations. Another percussion-type bit obtains both rotation and percussion through drill collar design. It can be lowered into the hole either on a hose or pipe which transmits the circulating fluid. Bits rotated with a turbine have been experimented with for years. One such bit has found some success in drilling on the West Coast. Such a bit might be particularly adapted to light speed and high rotation. The Russians have been experimenting with a turbine type bit for more than ten years.

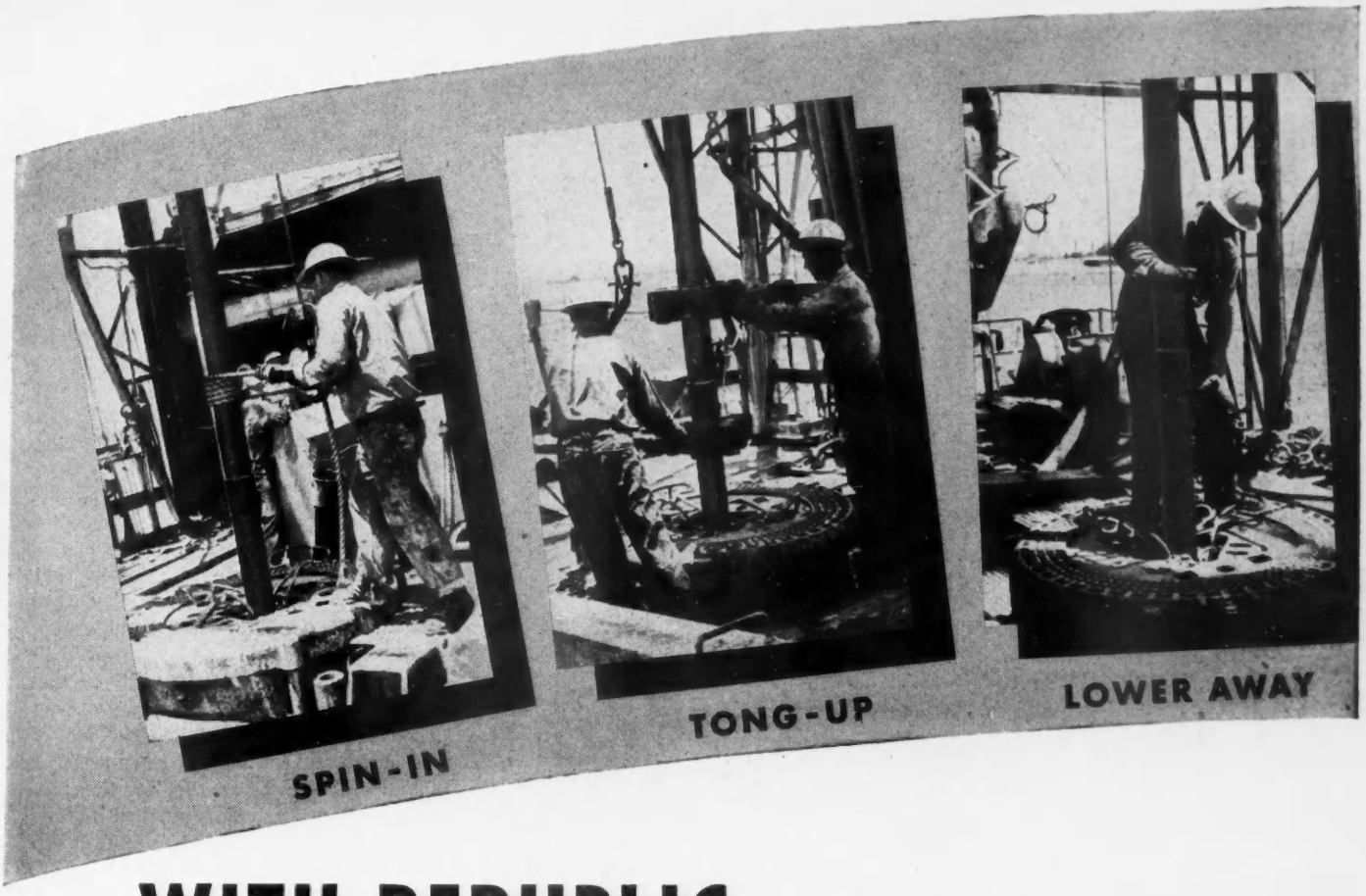
Drill Pipe Development

Drill pipe has kept pace with improvements by employing better steels and alloy metals as they have been developed. Tool joints have done likewise in the use of better steels, in thread design and application to the drill pipe. In the early days of drilling to shallow depths in soft formations, 4½-inch OD drill pipe was in general use. During the second decade of this century, the rotary developed at an accelerated rate on the Pacific Coast, and the methods and general equipment employed there were introduced in Oklahoma during World War I. All of the rigs used six-inch drill pipe. For several years throughout Oklahoma, West Texas and New Mexico, many feet of hole were made with six-inch drill pipe and some is still in use. But in general, 4½-inch OD drill pipe has been used to drill practically all the holes since the late 1920's. Some 3½-inch drill pipe, of course, is used for making hole in certain areas and under certain drilling conditions. In some fields of West Texas, a great deal of 3½-inch drill pipe is used to make the hole below the salt string. In the past few years, five-inch OD drill pipe has been introduced to the drilling industry.

Higher circulation rates at any given horsepower as well as greater torsional strength are offered by five-inch drill pipe as compared with the 4½-inch pipe. At a circulating rate of 900 gallons per minute, the pressure loss through five-inch OD drill pipe with internal flush tool joints is 160 pounds per square inch per 1000 feet; for 4½-inch external upset internal flush drill pipe with internal flush tool joints, the pressure loss is about 270 psi per 1000 feet. The horsepower required to circulate 900 gallons per minute through 5-inch OD drill pipe is 40 percent less than that required to circulate the same volume of mud through 4½-inch OD drill pipe. The 5-inch OD drill pipe offers 33 percent more torsional strength than 4¼-inch drill pipe. The cost of five-inch OD drill pipe is $.41 per foot more than 4½-inch OD drill pipe, which adds $5740 to the cost of a 14,000-foot string. However, in order to provide the same circulation rate with 4½-inch pipe, on a steam rig for example, an additional pump and boiler would be required. One company uses a string of 5-9/16-inch range three drill pipe in West Texas with extra-hole tool joints. This pipe is practically outside flush and lift plugs are used to handle it. With this pipe using 900 gallons per minute circulation, the pressure drop is approximately 80 psi per thousand feet of hole. This pipe has been used for 2½ years on a power rig with satisfactory performance.

Corrosion Fatigue Research

The American Association of Oilwell Drilling Contractors employed the Batelle Institute of Columbus, Ohio, to initiate a drill pipe research program, the need for which reached a climax in West Texas during World War II. The circumstances contributing to this drill pipe failure in West Texas appeared to be a combination of chemicals in the formations and the density of the formations that began to be penetrated on a large scale at that time. Drill pipe manufacturers were, at the same time, conducting experiments on mud inhibitors and checking drill pipe failures. Sodium chromate was recommended by Batelle as a mud inhibitor to reduce corrosion fatigue of drill pipe. It also has been claimed that one of the pipe manufac-



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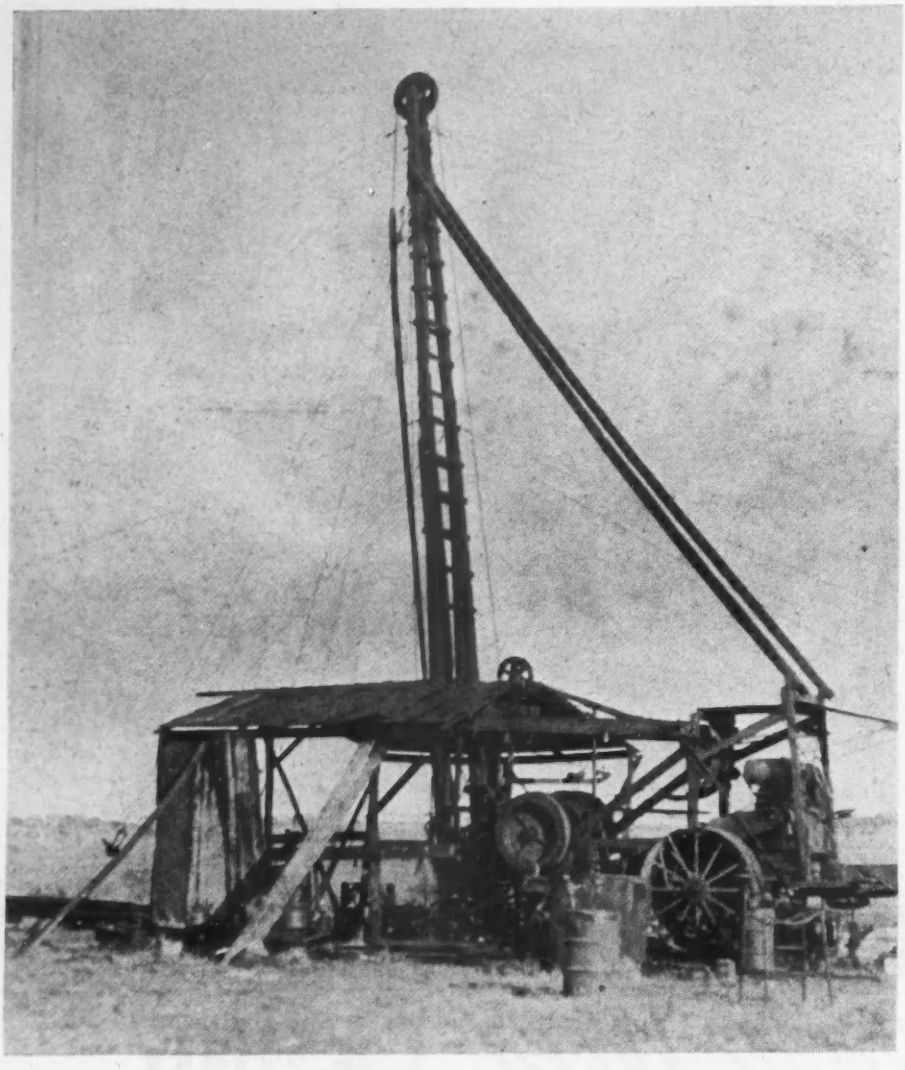

Typical early model cable tool rig in general use throughout the Mid-Continent for developing relatively shallow fields. Mast, braces, and framework were constructed of wood.

turers was the first to recommend it. Regardless of who thought of it first, its use has apparently resulted in some reduction in corrosion fatigue failures. Internal plastic coatings for drill pipe have been introduced recently, and have given good results.

At the time the drill pipe research program mentioned above started, many of the drill pipe failures came so quickly after the new pipe was put into use that it appeared possible that production methods used by drill pipe manufacturers had become lax. It also was considered possible that certain alloys used before the war had been reduced, and the resultant slight change in alloy content might be the cause of drill pipe failures.

The Batelle Institute first made exhaustive corrosion fatigue tests of drill pipe material without arriving at any conclusions that materials used were improper. Batelle now is working on methods of non-destructive testing of drill pipe with the idea of possibly developing methods which would be adopted by drill pipe manufacturers to provide the inspector with more complete and precise information concerning defects, to locate them, and if possible to discriminate between them in a useful manner. Aims of the program are to arrive at non-destructive inspection methods designed to make possible more reliable, faster and more economical inspection. This research includes practical, non-destructive methods of inspecting new drill pipe for mill defects and used drill pipe for surface defects and incipient washouts or twistoffs. This research is still going on and it is believed that it will result in improved methods of drill pipe inspection.

Experience indicates that perhaps much of the reduction of so-called corrosion fatigue failures has resulted through maintaining drill pipe in tension using long drill collar strings and slow rotating speeds.

Application of drill collars was formerly limited to four or five in a string until deep drilling in West Texas showed the need for greater weight on drilling bits to accomplish desired speed of penetration. Now it is general practice in West Texas and other hard rock areas where the formations are lying fairly horizontal to use long drill collar strings, in many instances as much as 600 feet long. For efficient penetration in some hard formations, as much as 40,000 pounds must be applied to an 8¾-inch bit and 25,000 pounds to a 6¾-inch bit. Forty thousand pounds of weight would require 2760 feet of 4½-inch drill pipe in compression.

It is very easy to visualize that compression of this order in drill pipe would bend it so that a considerable amount of weight would be supported by the walls of the hole and therefore would not produce the required weight on the bit. Furthermore, it also is easy to visualize that drill pipe under these conditions would twist off, break and wear out at a very fast rate. Nevertheless, it was with considerable trepidation that the first long drill collar strings were run, due to the fact that trouble had usually been encountered with long drill collar strings. But here again, experienced men overcame the majority of past difficulties and have made the use of these long drill collar strings successful. They were able to do this by close attention to workmanship on drill collars, joints, lead content of tool joint lubricants, attention to straight, true bore and balanced drill collars. In other words, to successfully use 600 feet of drill collars, old methods and care had to be discarded. New types of drill collar joints have been designed with success. One company developed a 90-degree thread with cold rolled thread roots and flame hardened shoulders. It is natural that there are some drill collar failures, and fishing troubles are multiplied in these long strings. To begin with, some strings were designed for various size holes to permit washing-over, and in many cases this proved impractical. It is now the practice of many operators to use the maximum OD drill collar that can be fished for with an overshot.

Eighteen 5¼-inch OD collars have been made with 3½-inch extra-hole joint dimensions, using this 90-degree thread design. The joint shoulders were flame hardened on 15 collars and only the pin shoulders were flame hardened on three collars. These collars have drilled two 7100-foot wells from the salt string in one field (4200 feet), and four 8500-foot wells from the salt string in the Fullerton field, (4000 feet) without a failure. The speed of rotation used was from 65 to 80 rpm, which is from 10 to 20 rpm faster than has been normally employed using ordinary designed joints in long drill collar strings. The flame hardened boxes showed some hair cracks and the three non-flame hardened box collars showed

■ CONTINUED ON PAGE 112

Effect of Hole Enlargement on Cementing and Completion

by

BRUCE BARKIS
and
KENNETH A. WRIGHT
B & W Incorporated

DISCOVERY OF new oil fields is becoming more difficult and costly. Improvement of completion practices is an alternative means of increasing national petroleum reserves. The drilling section of the industry is continually striving to perfect these practices. This paper reports recent developments in completion techniques. Caliper surveys, hole enlargement, drilling fluids used in the producing section, and some of the problems encountered in cementing and completing wells are discussed.

SINCE the development of the hole caliper by Myron Kinley and its introduction to the industry in 1940-41, many problems concerning cementing and completion practices have been clarified. In the early days of rotary drilling the importance of good mud control was not appreciated and stuck drill pipe and serious fishing jobs were very common. It is realized now that this undoubtedly was caused by thick high water-loss muds and enlarged holes.

While there has been a general improvement in drilling mud, and a considerable reduction in the amount of fresh water lost into the formations, caliper surveys show that hole enlargement still persists.

This hole enlargement adds considerably, both directly and indirectly, to the cost of drilling and completing wells, and further improvement of our drilling fluids is necessary before all wells are "drilled to gauge."

By 1932 a clearer understanding of the varying qualities of drilling fluids, the effect of the filtrate on the productivity of the sands, and the need for cleaning rotary drilled wells was developing. Rubel[1] stated "In semi-depleted fields, however, where formation pressures have declined to small figures, the problem is most serious. There are numerous instances where in sands known to be capable of producing 50 to 250 barrels per day production, no oil can be produced commercially at present with rotary drilled holes, and where, unless other means are employed, large reserves of oil will be lost to the industry."

Mud Cake Formation

As far back as 1922, one of the larger operating companies included in a report on drilling fluids the statement, "The speed of the mudding off process is practically instantaneous." This fact, however, if often overlooked or ignored in current operations.

In testing a sample of mud for its water-loss rate in the pressure cup, the 100-pound pressure used forms a large percentage of the mud cake in a few seconds. The identical action occurs in the well only more rapidly because of the greater differential pressures, higher temperatures, drilling fluid contamination and other factors contributing to the thickness and type of mud cake.

There is a continuous disturbance of the filter cake while the drill pipe is being run in, pulled out, or rotated, and during the reaming, scraping or scratching operation. A new cake immediately forms, however, composed of the disturbed material—bit cuttings, sand and other solids in the drilling fluid. The filtration rate for this wall cake undoubtedly is more than for a carefully selected sample from the ditch and the amount of water lost by filtration into the formation would be greater.

This conclusion was verified in a recent completion. The hole was conditioned prior to running slotted liner, and the oil emulsion mud weight, as the drill pipe was pulled from bottom, was 70 lbs. cu./ft. (9.3 lbs. gal.) with an average filtration rate of one cc. It required 14 hours to pull out, make up the slotted liner assembly, including wash pipe to bottom, and run to bottom. When circulation was established, and returns from bottom recovered, the mud weight had increased to 80 lbs. cu./ft. (10.6 lbs. gal.).

An analysis of the complete data on this installation showed that the amount of water lost from the mud was far greater than indicated by the one cc. rate in the testing apparatus.

Hole Enlargement

Hole enlargement may be defined as the increased volume of the drilled hole over the cylinder whose diameter equals the bit diameter. The causes of hole enlargement include: (1) water infiltration; (2) nature and content of the formations; (3) behavior of the drilling string.

The action of the filtrate from the drilling mud in swelling, disintegrating, caving, eroding and enlarging the drilled hole has been recognized for some time. A recent study shows the varying amounts of hole enlargement when the same formation is drilled with different fluids. This survey (Figure 1) shows more hole enlargement in the well drilled with fresh-water mud and indicates that the holes drilled with oil emulsion and oil-base muds are very "close to gauge." This latter conclusion recently has been questioned, however, and there is evidence that some of the enlarged sections have been filled in or "plastered" with fairly dense mud cakes.

A comparison of the mud cakes recovered with mechanical sidewall coring devices on sand or shale formations shows a considerable difference in thickness and character. As a general rule the mud cake recovered from the shale sections is fairly thin, while mud cakes from ½ to two inches thick are common in the sandy sections. In several wells the productive section below the casing has been cleaned with rotating scratcher assemblies. In the normal wall-scraping operation a large amount of the material

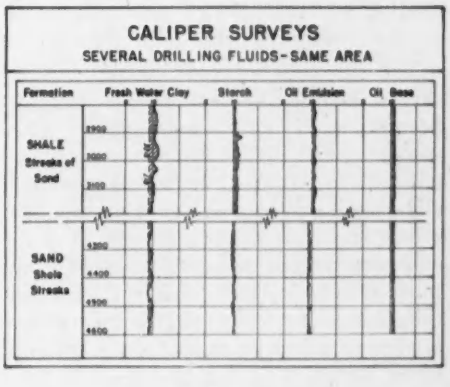

FIGURE 1

[1] Paper presented before the American Association of Oil Well Drilling Contractors, October 13-14-15, Long Beach, Calif.

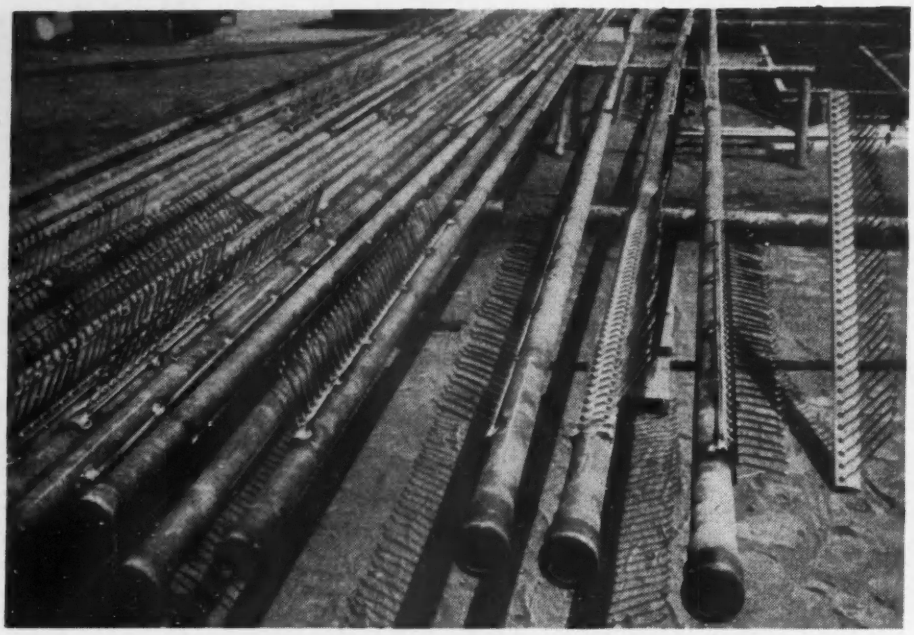

FIGURE 2. Rotating scratcher assembly for open hole cleaning.

removed by scraping is redeposited above the scraping assembly. To avoid this redeposition, an assembly was run recently as shown in Figure 2 throughout the entire open hole section and the drilling fluid was displaced with clean oil. Salt water of increased salinity can be used and has the added advantage of flocculating the mud and further cleaning the open hole section.

The amount of material recovered during the scratching and washing operation as shown by the mud cake, bit cuttings and other solids recovered on the shaker would represent a sizable increase in hole diameter. It is now planned to run a followup caliper survey on the next test to measure this increased diameter.

With the development of the caliper survey it has been possible also to measure the varying amount of hole enlargement during the drilling life of the well. Four surveys of the same well are shown in Figure 3. It is apparent that the hole contour is not constant, and that extensive filling with mud cake of sufficient strength to withstand the pressure of the caliper arms is indicated at certain depths, while continued enlargement is shown at other depths.

The chemical composition and hydrocarbon content of the formations have been reported as responsible for varying amounts of hole enlargement,[3] and the effect of the drilling string through misalignment, excess weight on the bit and other factors on the amount of hole enlargement has been investigated,[3] but most studies indicate, that the effect of the fresh water filtrate on the formations is of more importance, and there appears to be justification for the general conclusion that the amount of enlargement is closely associated with the amount of fresh water lost in the formation.

The cementing tests reported by Jones and Berdine[4] in 1940 were the first to disprove the widely accepted belief that cement slurry scoured the mud cake from the formation face. These tests included all equipment available at the time to improve the contact of the cement with the formation and concluded in part, "Whenever cement slurry is applied opposite formations having appreciable permeability, a residual mud cake will remain between the set cement and the formation unless specific measures are employed to effect its removal."

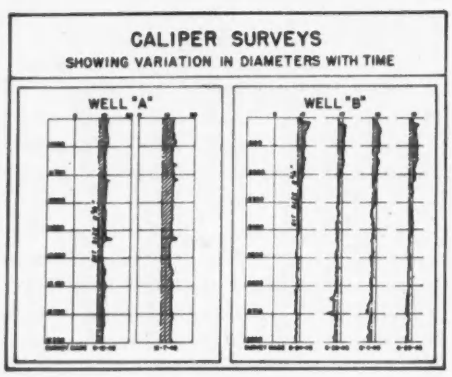

FIGURE 3

Similar tests were made more recently in actual well installations. These were reported by Teplitz and Hassebrook[5] in 1946, and included comparisons between the results obtained in cementing "bare" casing which was not moved during the cement placement, and with casing equipped with scratchers and centralizers, and moved during the cementing operation. Their report states: "The usual casing cementation ends up with the annular column consisting roughly of half cement and half mud, i.e., over the total distance pervaded by the cement," and their conclusion reports "By properly equipping the casing with scratchers and centralizing devices, reciprocating the pipe while placing the cement, and speeding up the rate of pumping, it has been practically possible to eliminate channelling and thus greatly increase the proportion of successful casing settings."

When cement slurry is pumped around casing and into an irregular annulus, as shown in Figure 4, the cement slurry displaces only a portion of the mud in the annulus volume. The velocity of the upward traveling slurry varies from two to five feet per second, which is in the viscous flow range. The forces exerted at these velocities are insufficient to put all of the drilling fluid and mud cake in the annulus into motion.

The cement slurry therefore travels upward at almost constant velocity and not at the variable velocity which would result from complete displacement of the mud in the enlarged sections. The percentage of cement fill undoubtedly would be higher in a hole of constant diameter, and, in addition, the effectiveness of centering and scratching equipment would be increased.

Setting of Cement Slurry

In mixing cement slurry for usage in an oil well, more water is used than is required to hydrate the cement particles. It has been assumed that this excess mixing water "went into the formations," which, considering the amount of cement normally used, involves the disposal of 25 to 50 barrels of water.

With the introduction of improved drilling fluids, having low water-loss rates, the problem of what happens to this excess mixing water becomes more important. Tests in long impermeable cylinders indicate that the water and cement settles out in layers, a condition which would not be desirable behind the casing string.

The filtration rate into shales is very low in relation to the setting time of the cement slurry. This suggests that

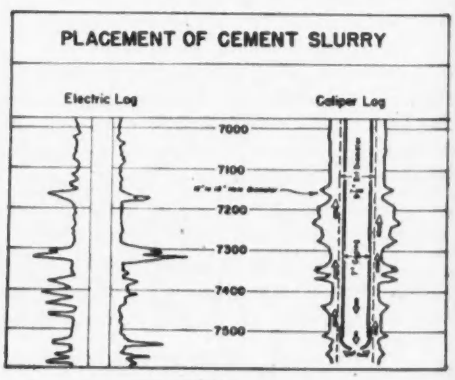

FIGURE 4

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provision should be made for filtration of the excess water into the sand members. The mechanical approach of abrading the mud cake from the sandy formations appears to be the most direct means of providing an outlet for the filtration of this water. Though the cement slurry itself will not penetrate into the sand formations, the filtration of this water, carrying minute colloidal particles of cement, will greatly improve the bond between the cement and the formation.

It has been demonstrated that cement slurry placed opposite a clean sand surface and subjected to 500 pounds pressure will set almost instantaneously. This does not increase the normal cementing hazards, so long as the cement slurry is kept in motion, and a small percentage of bentonite added to the cement. This addition of bentonite to the cement slurry will not only lower the filtration rate, but will aid in absorbing excess water, in lowering the tensile strength of the set cement, and in increasing the volume of set cement.

Conclusions

Clay-base fresh water mud is being used in a majority of the current rotary drilling in the U. S. In field terminology it is described as "good drilling mud." This description may not be entirely correct, and may be altered when it is more widely realized that such drilling fluids are responsible, in a large degree, for the hole enlargement that causes many of our cementing and completion failures.

The cost of drilling has been shown to be closely related to the size of the drilled hole[6] or, in other words, to the amount of the material excavated. This situation undoubtedly applies to either intentional or unintentional enlargement and suggests that drilling costs should be more favorable for holes drilled to gauge. The possibility of sticking drill pipe or of having very difficult fishing jobs is more remote when a drilling fluid has been selected that will maintain the drilled hole closely to the bit diameter.

Reduction of lost rig time in fishing operations, in correcting cementing failures, or other completion difficulties, can only increase the percentage of time that the bit is on bottom in the hole-making phase, which is the goal of all contractors.

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Drilling Industry's Progress

■ CONTINUED FROM PAGE 106

none. Less trouble has been experienced with the smaller OD joint probably because the average rig can make up the joints tight. The average rig equipment can make up joints with about 25,000 foot-pounds torque and it is calculated that 40,000 foot-pounds are required to make up a 6⅝-inch joint.

A safety joint to be included in drill collar strings has been developed, thoroughly tested and considered successful. This would permit washing-over a part of a drill collar string, removing that part and washing-over the remainder. This would be a great help.

Drilling Fluids

The development of commercial drilling muds and chemicals for mud treatment has been one of the most important contributions to drilling technique during recent years, and has been one of the factors definitely essential to successful drilling of deep holes. In the past few years, pump repairs on wells have rapidly decreased, due mainly to better drilling mud. Jells used in the mud and the small percent of sand retained in the mud by controlled viscosity greatly reduced wear on liners, pistons, and valves. Several years ago, a set of pump liners often would not make one well and now pump liners are seldom changed until they have drilled many wells. The same thing is true of valves and inserts. Many oil companies have done considerable research work on drilling fluids, and service companies selling mud and chemicals have done a great job in supplying the industry with mud "know-how."

Approximately two years ago, the American Association of Oilwell Drilling Contractors joined with the Vocational Training Department of the University of Texas in sponsoring mud schools that have been conducted throughout the Mid-Continent, Southwest and Rocky Mountain areas. These schools have dealt entirely with the art of using mud in order that they may be kept to the level of the driller and roughneck. Much has been accomplished by this program in bringing improved technique in handling drilling fluids with the resultant overall improvement of economy and efficiency in drilling.

In the last few years, wells have been drilled deeper and deeper. All those engaged in drilling wells and providing machinery and equipment for this purpose have been giving much thought to the proper equipment and technique for successfully drilling 15,000-foot and deeper wells. Many very deep wells have been drilled successfully. A few special rigs have been designed and manufactured for efficient drilling below 15,000 feet. These rigs have all been designed and manufactured for major oil companies, and this is readily understanda because some of them have cost as m as $650,000 or $750,000.

In January, 1947, Standard Oil C pany (N. J.) sent out a letter with attached questionnaire to drilling c tractors, to get their opinions on tre in drilling equipment and costs. summary below represents a joint o ion of 23 contractors or 50 percen whom questionnaires were mailed. results of the survey in the opinio Standard, are representative of the dustry's thinking inasmuch as contr tors from the Southwest, Mid-Contine Rocky Mountain and Pacific Coast c tributed to the study.

Summary of Drilling Contractors' Opinio On Trends in Drilling Equipment and Cos

No. Polled 46 — No. Participated 23 — % 50

1. "Do you expect reductions in cost of drilling tools and equipment?"
   10% No opinion
   30% Yes (10% reduction)
   60% No
2. "Do you expect any reductions in well drilling costs?"
   10% No opinion
   15% No reduction
   25% Reduction of 15%
   25% Reduction of 25%
   25% Reduction of 50%
3. "What is your opinion in regard to drilling cost of 15,000-foot wells?" Would estimated drilling cost of a 15,000-foot well be 25%, 50%, 100%, or higher in comparison to the cost of 10,000-foot wells?"
   5% No opinion
   5% 25% higher than 10,000-foot wells
   20% 50% higher than 10,000-foot wells
   70% 100% higher than 10,000-foot wells
   Average 85% higher than 10,000-foot wells
4. "What is your opinion in regard to drilling costs of 20,000-foot wells?" Would you estimate the drilling cost of a 20,000-foot well to be 50%, 100%, 150%, 200% higher than the cost of a 15,000-foot well?"
   5% No opinion
   5% 50% higher than 15,000-foot well
   20% 100% higher than 15,000-foot well
   45% 150% higher than 15,000-foot well
   25% 200% higher than 15,000-foot well
   Average 150% higher than 15,000-foot well
5. "What is your opinion in regard to future drilling cost of 10,000 and 15,000-foot wells?"
   5% No opinion
   25% Present cost maintained
   40% Cost will increase (10-25%)
   30% Cost will decrease (20-25%)
   Average opinion—Present cost maintained
6. "Do you expect important improvements in drilling equipment and techniques?"
   0 No improvements
   50% Slight improvements
   50% Major improvements
7. "If, in your opinion there would be major improvements in drilling equipment, what type of improvements do you expect?"
   20% No opinion
   55% Better and heavier equipment
   25% Radically new equipment
8. "Do you feel that a new drilling method and technique must be developed to drill deep wells more economically?"
   75% Yes
   25% No
9. "If you think that a new drilling method and technique to drill deep wells is needed, who in your opinion should develop such method?"
   0% Equipment manufacturers
   0% Drilling contractors
   0% Oil producing companies
   100% By joint effort of manufacturers, drilling contractors and companies.

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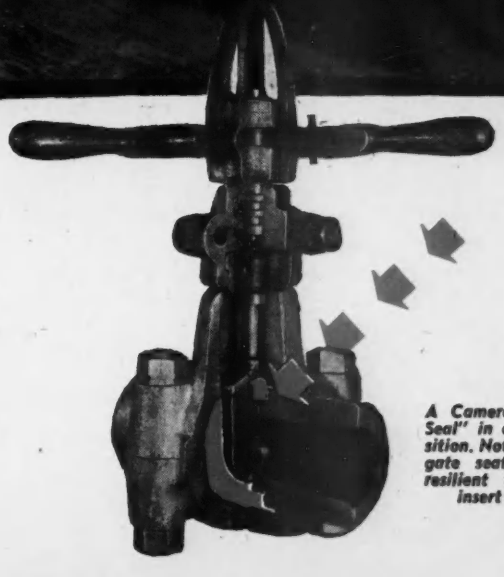
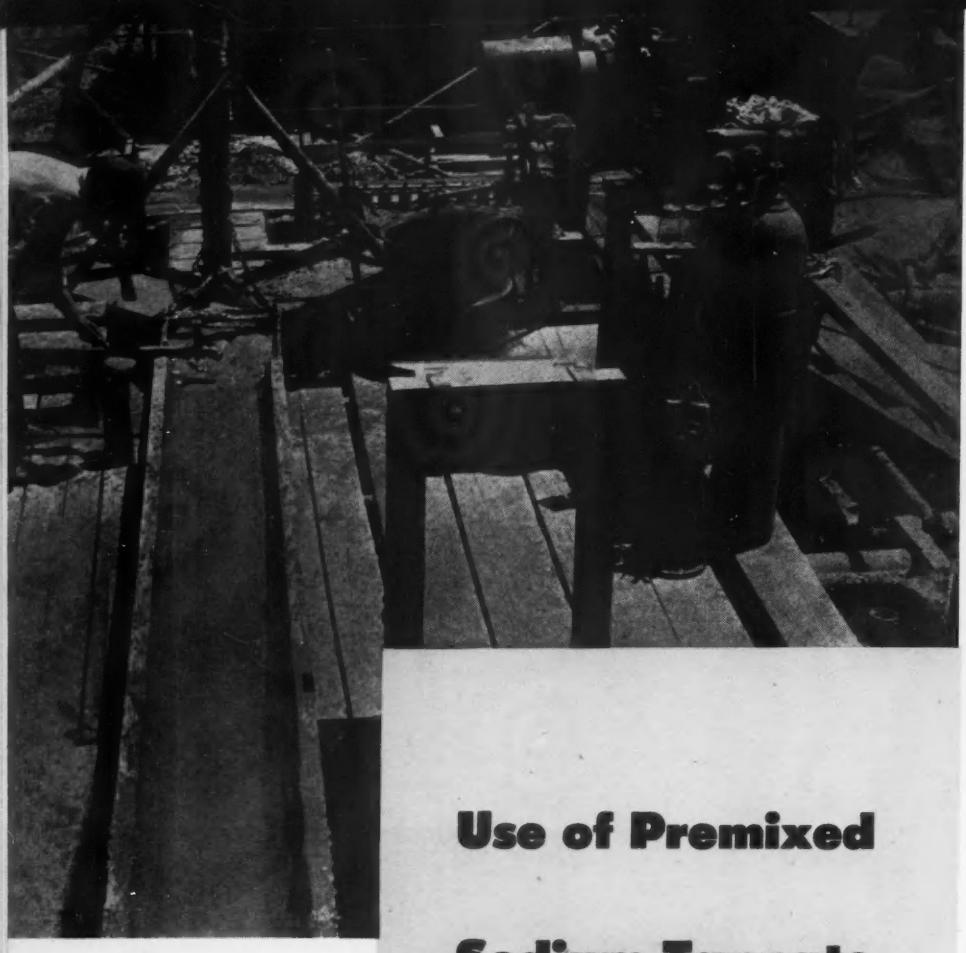


A Cameron "Flex-Seal" in closed position. Note how the gate seats in the resilient flow-way insert (red).



Use of Premixed Sodium Tannate Solutions

By J. T. CLARKE
Chemical Engineer,
Dixie Chemical Company, Houston,
and
L. R. SURBER
Field Mud Engineer,
Hudson-Houston Lumber Company,
Oklahoma City

THE use of caustic soda and quebracho is well recognized as an established procedure in conditioning drilling fluids. Until recently, however, these chemicals were delivered to the rig in dry form, where they were mixed into a water solution by various methods and then introduced into the mud stream. The physical and chemical properties of flake caustic soda and dry quebracho tend to make this mixing difficult, dangerous, expensive and inaccurate. This is especially true on power rigs where no steam is available. Storage of the dry materials on location also presents a problem, since both materials deteriorate rapidly when exposed to air.

In view of the many unfavorable characteristics of handling caustic soda and quebracho in the dry form, a premixed concentrated solution of these two materials has been developed called "Red Mud," which has been placed on the market through supply dealers. This product has eliminated most of the objectionable features of the dry materials; but at the same time has retained the properties required in effective mud conditioning. In addition it is easily stored and diluted for use. A solution of this type was made and used previously by a major oil company in the Gulf Coast area, but was discontinued because of difficulties encountered in its manufacture; however, these problems have been overcome.

Possibly the most objectionable factor in the use of "dry" materials at the well is resulting accidents. When caustic soda is dissolved in water, a great deal of heat is generated, and during the mixing operation some of this hot, corrosive, caustic solution may be splashed on workmen, resulting in at least minor injuries if not lost-time accidents. Rarely do personnel escape caustic soda burns to some degree when mud is conditioned with flake caustic and powdered quebracho. Although the premixed concentrate is a corrosive liquid and should be handled with care, it is by no means as dangerous to workmen as flake or liquid caustic soda. This is due to the fact that there has been a chemical reaction between the caustic soda and the quebracho, resulting in a compound that is less harmful to the skin.

As far as comparative costs are concerned, the premixed solution is somewhat more expensive; however, operators who have used Red Mud claim an overall saving which amounted, in most cases, to a reduction of 20 percent or more in chemical costs. In mixing the dry materials, considerable quebracho is lost through its tendency to form insoluble gum-like balls in the mixing tank. This insoluble material is thrown into the slush pit where it drops from sight but does no mud conditioning. It is difficult, if not impossible, to mix without wasting some flake caustic soda. Any flake caustic soda left in a drum and exposed to air takes water from the air and hardens. Usually it becomes impractical to remove all hardened caustic from the drums and eventually a substantial quantity is discarded with the caustic container. The dry materials in storage in the field mud houses are subect to deterioration and the mud bill on a well is often increased because the quebracho has set up in the bags and must be reground, and the flake caustic soda has solidified.

The ease of mixing chemicals and the "to-the-pound" accuracy experienced with the liquid premixed material is readily understood. The premixed concentrate is packaged in 15- and 55-gallon steel drums. At the rig location they are equipped with molasses bungs and are rolled onto a drum rack. The quebracho-caustic soda equivalent per gallon is indicated on each drum, and the exact amount for each treatment can be drawn easily from the drum and poured into the chemical tank. In this way the operator is assured that all the caustic and quebracho (sodium tannate) will go into the mud system in its most effective form. It has been found on application that where 25 pounds of flake caustic and 25 pounds of powdered quebracho are needed, five gallons of the premix concentrate is sufficient. Similarly, ten gallons of Red Mud does the treating of 50 pounds of dry flake caustic and 50 pounds of dry quebracho.

Red Mud is obtainable in the commonly used proportions of quebracho and caustic soda, and can be stored indefinitely in its original container either at the rig or in the warehouse. The material is easily diluted in water solutions with absolute accuracy and no resulting losses. Red Mud is not a substitute for dry caustic soda and quebracho; but is a successor to them, and is finding wide acceptance in mud conditioning practices throughout the country.

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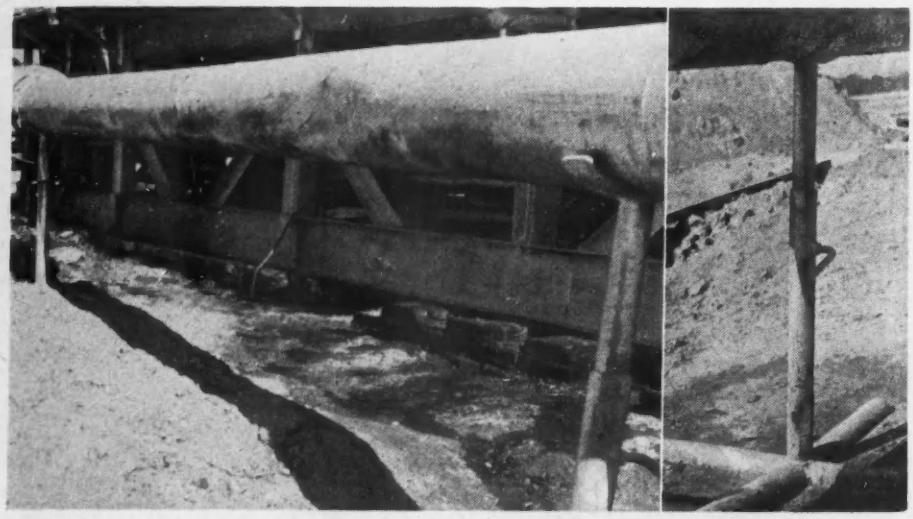
How To—Provide Adjustable Supports for Mud Return Trough



Because of the uneven ground surface at different locations, a mud flume fitted with adjustable supports can be leveled easily so the drilling fluid will flow to the shale shakers without forming pockets where cuttings may settle. The flume is made of large diameter, light weight pipe equipped with companion flanges.

The supports are made with a cross-type base, constructed by splitting a four-inch pipe nipple and welding a two-foot standard of two and one-half inch pipe in the center where the two pieces of four inch pipe cross each other. A thick boss is welded on one side of this standard, drilled and tapped to receive a threaded set screw made of rod material and shaped with a handle to permit tightening without the use of a wrench.

Inside this standard a piece of two-inch pipe is inserted and equipped with a saddle top upon which the mud flume rests. By sliding the two inch pipe up or down, the desired leveling of the mud flume can be obtained and locked in position with the bent handle set screw. Several of these supports are used to eliminate sags and to set the mud flume in position that the drilling mud will flow smoothly to the shale shakers.

How To—Mount Locomotive-Type Air Compressor for Ease of Handling

One contractor designed a compact and ingenious mounting for the locomotive-type air compressor which is used to "blow" the water well as well as power the air-actuated equipment on the rig. The compressor is mounted on the conventional skid of four-inch pipe, across which is welded a wide piece of heavy boiler plate. Hinged to this piece of plate is a second section, to which is bolted the air compressor. Two braces of heavy flat steel are pinned to a cross member on the skid, and also to a cross arm on the piece supporting the air compressor. When the compressor is to be moved, the upper pins in the braces are pulled and the compressor laid back flat. What was the top of the compressor support now rests on the cross member between the braces. These, in turn, are laid flat on the cross arm, and are pinned to lugs welded to the larger base plate and, as shown, are nearly hidden by the compressor.

When so secured, the compressor occupies a minimum of space, but is ready to be set up and its piping connected as soon as the skid is in place at the new location. The set-up required no hoisting of the unit, no laborious placing of bolts, and when the pins are again in place in the braces, the job is complete. Split cotters keep pins in position.

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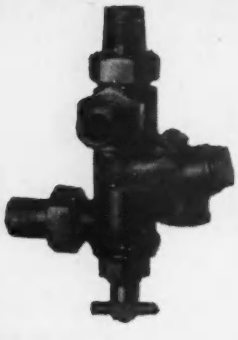

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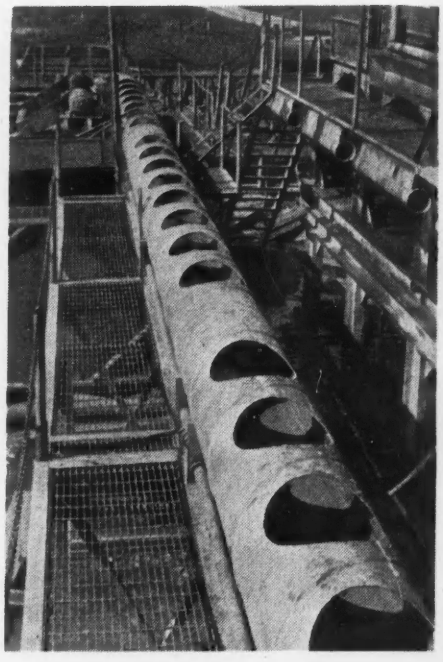
How To—Fabricate Durable Mud Return Ditch

Mud costs on deep Gulf Coast wells are normally high because of the varied formations penetrated which require special treatment of the drilling fluid. Mud-conscious operators are realizing more and more the importance of a closed mud system which will permit more efficient treatment and eliminate surface contamination and waste of costly mud.

One interesting design of a very desirable mud return ditch is illustrated. It has been unitized along with the ditch supports and adjacent walkways to facilitate its handling during rig moves and to save time and effort in setting the rig up or tearing it down.

The mud return ditch is made from 20-inch, spiral-welded casing in approximately 12-foot sections. Each section is joined to the adjacent section by a simple friction joint. The upstream section is belled slightly so that the next downstream section will fit snugly into this belled opening sufficient to make a mud-tight joint. The two sections are hammered in place to make the bond and are disengaged in the same manner.

Saddles cut to fit the contour of the 20-inch casing are welded at five-foot intervals to provide support for the casing and keep it in position on the pipe framework forming the unitized section. Elipses are cut in the upper side of the 20-inch casing to permit inspection of the mud. Enough metal is left between these eliptical openings so that the casing retains much of its original rigidity, and will withstand rough handling during moves.



How To—Ease Job of Stabbing Kelly

Close teamwork between the driller and the man at the cathead is required when a kelly is swung to one side and lowered into the usual rat hole. If it is windy, action of wind on traveling block and lines adds to the difficulty of landing the kelly, and considerable time may be lost.

One drilling contractor eliminates this uncertainty by notching the rat hole pipe for nearly two feet on the side farthest from the rotary. This notch or cut-away section amounts to nearly one third the circumference of the pipe, leaving a gap wide enough to easily accommodate the kelly sub. To use, the kelly is hoisted so that its bottom will come somewhere between the base of the notch and the top of the pipe. It is then pulled aside with the cathead, and swung by one or two of the crewmen until it is aligned with the notch. Slackening of the catline allows the kelly to be caught by the pipe, and alignment is assured as the driller slacks away at the brake.

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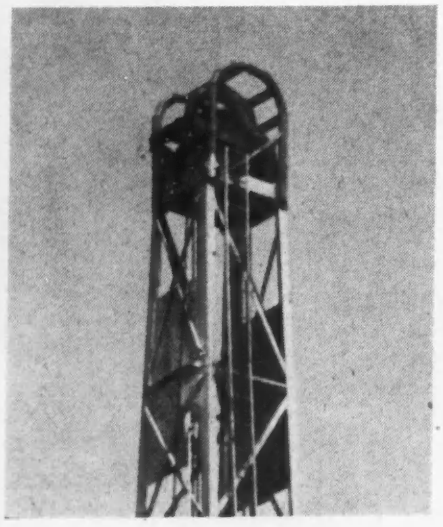
How To—

Protect Crown Blocks



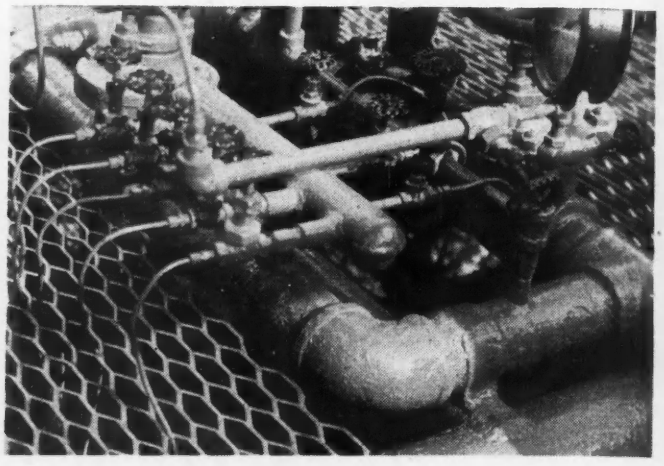
On small cantilever derricks, the crown block is usually left secured in position during rig moves. The upper section of the derrick is unbolted from the middle section and loaded onto trucks.

During this procedure and also during rigging up operations on the next location, the crown block stands an excellent chance of receiving heavy blows. This is especially true when dismantling or erecting the rig. Not only is it possible to have the crown block broken and knocked from alignment, but the precision roller bearings supporting the sheaves may be chipped or fractured, resulting in the necessity of buying a new block.

To obviate this possibility and gain the necessary protection from rough handling during loading and unloading operations, one contractor provided a special guard structure for the crown block on a cantilever type derrick. The protective structure is fabricated from two-inch pipe, each end formed in the shape of an inverted "U." Each of the four legs of the structure is welded to the derrick legs. Cross bracing is provided by welding additional pieces of two-inch pipe between the two "U" sections, thus making a rigid structure. These cross pieces cover only half of the unit, the other half remaining open to permit access to the crown block in stringing up the drilling lines and making it possible to repair the block if necessary. The opening is sufficiently large to permit the crown block to be removed completely.

How To—

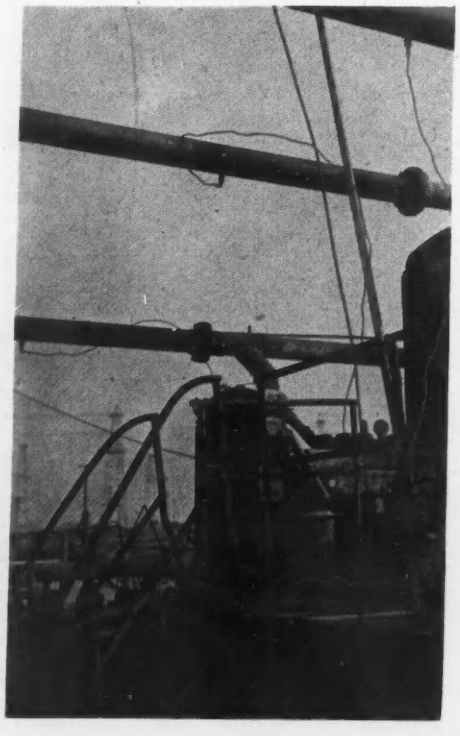
Group Fire Box Pilot Control Valves



One drilling contractor has included a grouping of pilot light control for the boilers at a convenient place easily reached by the fireman. A small header is placed above and welded to the fuel regulator setting, and contains leads for as many as eight pilot lights. Small bar-stock valves are fitted to the header with attachments to connect annealed copper tubing that carries gas to the boiler pilot burners. By using this arrangement, a constant and continuous supply of fuel is always placed in the pilot burners regardless of the condition of the main heater burners. Firebox explosions are prevented by the boiler fireman being able to light a pilot flame with a torch before turning on the main supply of fuel.

How To—Eliminate Sparks in Engine Exhaust

The exhaust of gasoline engines used to power drilling rigs in gas or gas-distillate areas is a definite hazard unless proper precautions are taken to prevent the exhaust sparks and flames from flying in the atmosphere near the well head. One California drilling contractor combats this situation with unique devices that have proven adequate for the job and very efficient.



Principle of the method lies in injecting a small stream of water into the exhaust pipe of each engine. The water is immediately entrained in the exhaust gases and extinguishes any flame or spark that might be discharged from the prime mover.

Exhaust from each of three engines is piped through four-inch lines and discharged at a safe distance from the rig floor. A one-inch collar is welded to the bottom side of each exhaust line at a point about four feet from the engine exhaust. A ¼-inch copper tubing is connected to this one-inch collar, the other end of the tubing terminating at the water pipe. Here, a manifold is made to accommodate all three lines which are provided with individual valves, making it possible to control the flow of water into each exhaust independent of the other. The four-inch exhaust lines slope downward toward the open ends so that if the engine dies or is shut down for a short period, water will flow out harmlessly.

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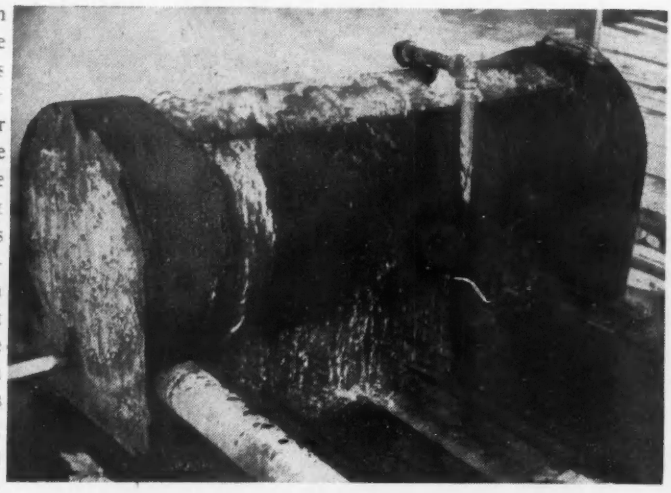
How To—Construct Crew's Clothes Washer



A five-foot section of 18-inch pipe, the ends closed by pieces of tank steel which also form the legs or supports, was made into a very effective clothes washer. The top was cut out as shown in the photograph, and a steam line brought in at one end, near the bottom. The steam line extended across the base of the unit, and carried small holes drilled into it at intervals. All these holes lie in the same plane, directing the jets of steam tangentially around the inside of the pipe.

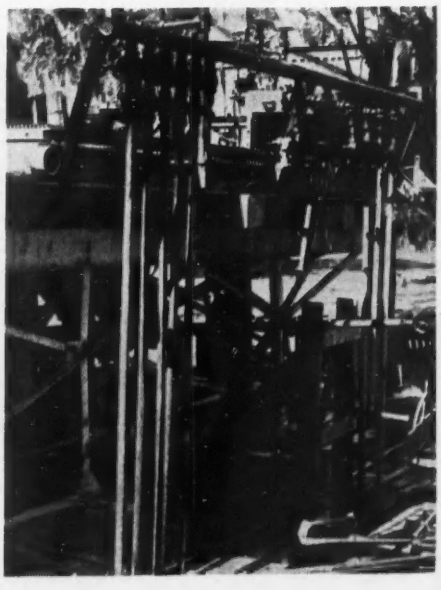
A water line was placed above the unit; clothes, washing powder and water put in, and the steam turned on. Action of the steam tended to rotate the water and clothes around inside the cylinder, while condensation of the steam raises the temperature to near boiling.

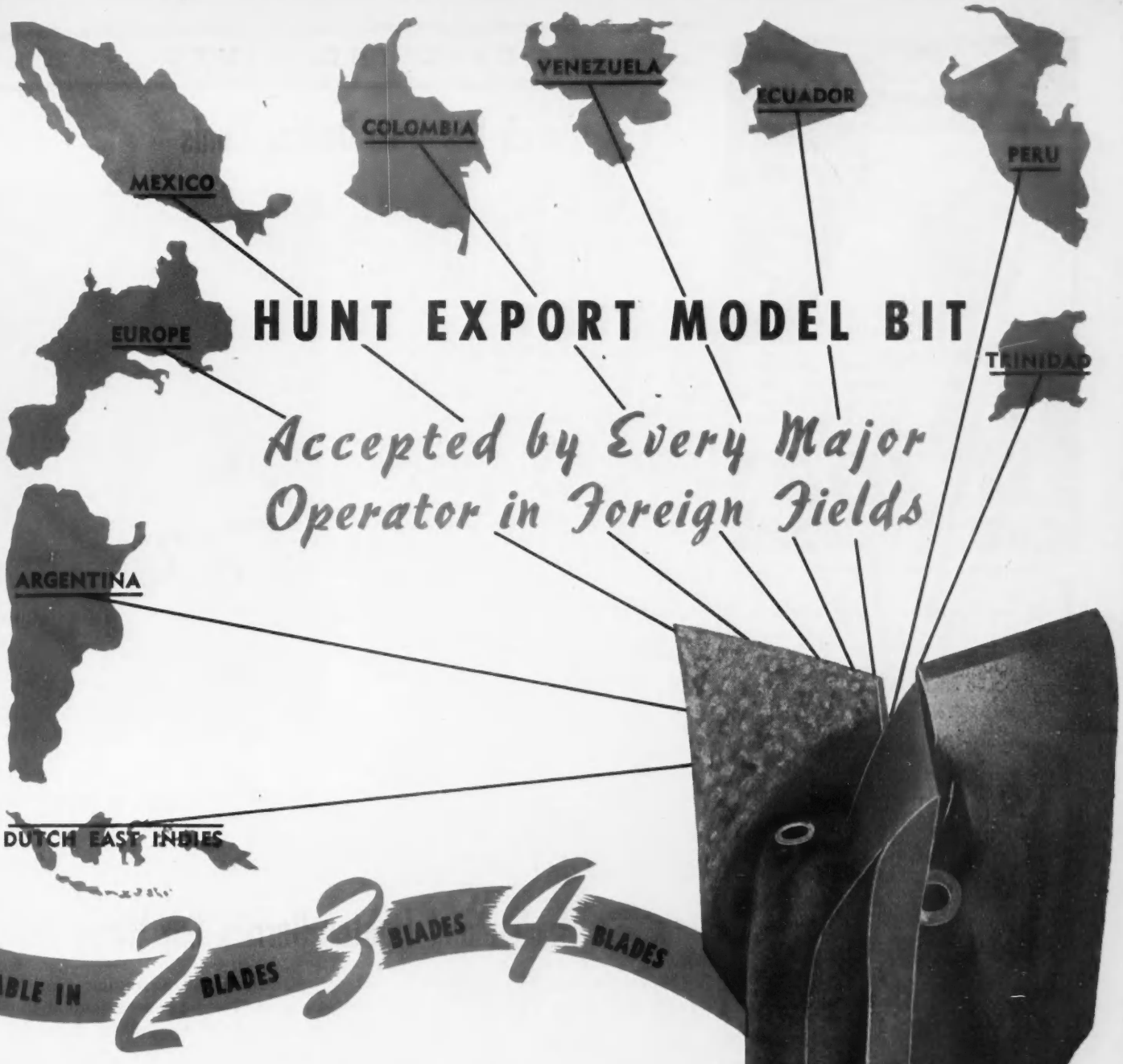
The swirling mass swished the suds through the clothes, some of the water slopped over at the top as more was added. Dirt and scum, floating to the top, was thus skimmed off and the clothes cleaned and rinsed thoroughly without being handled. A drain fitting in the end opposite the steam inlet permitted the washer to be drained after use.

How To—Manifold Fluid Lines on Derrick Floor

All service connections for water, steam and mud are brought into a special skid to provide grouped control. A heavy skid, welded up from five-inch pipe and six-inch I-beams, is made up to fit between two of the corner posts of the derrick, and takes the place of a portion of the usual rig floor. The skid is shod with non-skid steel plates, and is heavy enough to remain rigid under rig vibration. The overhang is supported by extending two or more of the beams supporting the main floor of the rig.

A joint of drill pipe, carried on heavy brackets welded to the skid, serves as manifold and as railing along that portion of the floor. At one end (nearest the driller) are valves which control admission of steam, air, water and mud to the horizontal run. At the opposite end are the interlocked valves controlling the blowout preventers. All connections terminate in unions just below the valve sections of the lines so that the skid is made up or disconnected simply by breaking the unions, all valves and controls remain on the skid. The steam-heating coil at the driller's stand is mounted on the inner side of the skid, and takes steam from the header through a line beneath the steel floor. On the move, the heavy skid serves as a platform for transporting small parts of the rig.





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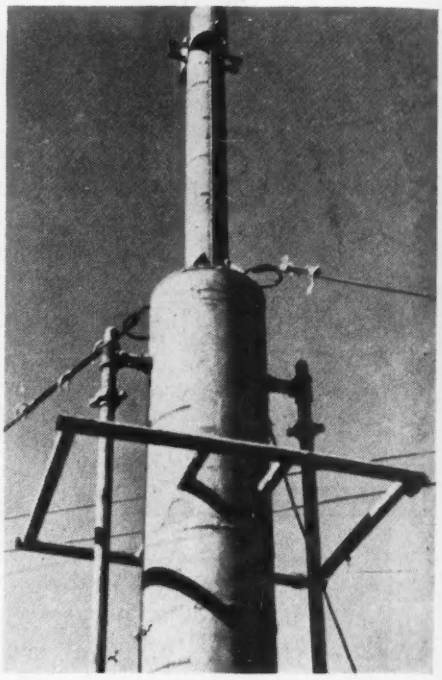
How To—Knock Gas from Drilling Fluids

An efficient method for the release of entrained gas from a pit full of drilling mud has been developed so that it can be used again on circulation after a minimum time elapse. A 24-inch tower is constructed to be set vertically, and having side-to-side pans installed inside the shell to force the mud to break in flow as it falls from the top to the base. Connections are made near the top for two entrance lines leading from the mud mixing pump, each entrance connection fitted with hard metal nozzles pointing directly towards each other to break the flow of fluid into a finely divided mass in this part of the chamber. A stack connected to the top head of the vessel dissipates the released gas into the atmosphere high enough to prevent fire hazard. De-gassed mud flows from outlets in the base to designated pits, or back to the original tank for recirculation, if required.

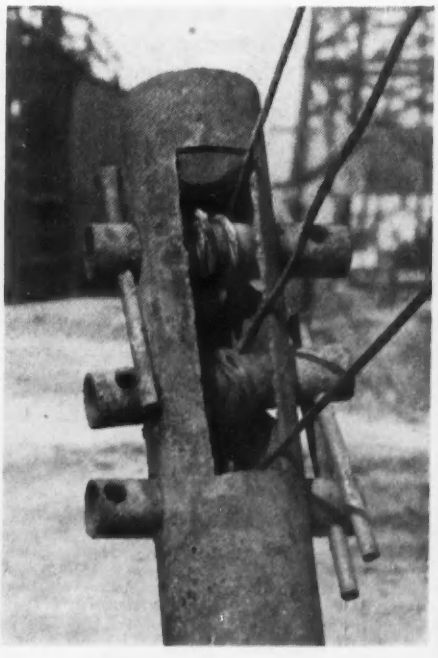


A rectangular framework of 2½-inch pipe was welded to the degasser near the upper section just below the two mud line connections. The frame was attached to the vertical chamber by means of four short nipples welded to the degasser and to the frame. Function of this unit was to provide protection for the thin shelled degasser during rig moves. It also provided means for preventing the cylinder from rolling once loaded onto trucks.

How To—Anchor and Tighten Derrick Guy Wires

When guylines are attached to derricks with regular wire line clamps, the job of taking up the slack in individual guylines is a difficult and tedious task, frequently left undone, just because a lot of time is involved. But the job can be resolved into a one-man task, and easy at that, when adjustable tighteners are installed.

A joint of heavy casing is set for the "dead-man," grouted with concrete if necessary to prevent moving when tension is applied. Smooth holes are cut through both walls of the pipe at right angles to the derrick, and into which two-inch pipe is placed for attaching the dead ends of the guy lines. A rectangular window provides an opening through which the lines are passed when they are connected to the two-inch pipe. These short pieces of pipe have holes in the walls near each end through which pieces of sucker rods are thrust and used as crank handles when applying the initial stretch of the lines and when taking-up any slack in the future. To lock the tightener in the position desired, a bar in one end holds the line tight while another bar, or short piece of rod is inserted in the opposite end and locked against one of the other tighteners.



DRILLING HINTS

How To—

Build Durable Vee Ramp

The vee ramp of drilling rigs can be fabricated from metals or wood depending on the choice of the operator, and each material has its advantages. Illustrated is a unique design of a durable ramp employed on one drilling rig operating in West Texas. It is a single unit which combines the stairway to the rig floor and the metal ramp, so that both may be moved at the same time.

The ramp is supported primarily by two heavy angle iron braces which form the outer edges and provide a lip to prevent equipment from sliding over the sides. A heavy sheet of ½-inch metal plate is welded inside the angle iron to form the bottom of the ramp and it is this plate which bears the brunt of the wear and tear on the ramp. The angle irons extend to the ground and are connected together by a similar angle iron piece which adds rigidity to the unit.

At approximately pipe rack height, the metal plate is bent outward so that it rests on the pipe rack walkway, and thereby provides a scuff plate which prevents splintering the planking when heavy objects strike the end of the walk.

The stairway footing plates are made from two sections of smaller angle iron which are joined with expanded metal to provide a non-skid surface. These are welded to one side of the ramp and to another section of angle iron which supports the outer end of the foot plates. These two sections are joined together by welding to form one unitized piece.

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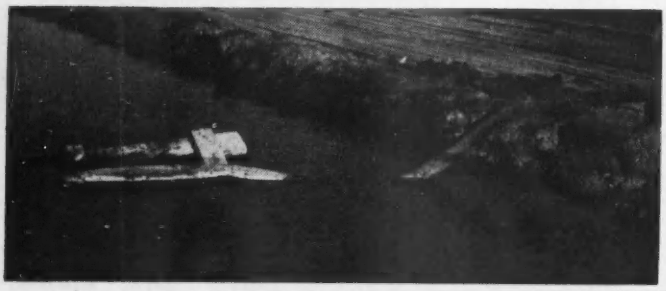
How To—Prevent Plugging Feed Water Suction



Clogging of boiler-feed pump suctions from mud at the bottom of the pit or sunken trash swept along the bottom by the flow into the hose is prevented by one contractor through the use of rafts or floats. The float was made up of two 8-foot pieces of 8x8-inch timber, fastened a short distance apart with 2x6-inch cross pieces. The suction hose was tied to these cross members, with the strainer end hung about two feet below the surface.

A piece of junk was tied to the float, and dropped overboard to serve as anchor. This prevented wind or wave action from washing the suction hose against the bank and defeating the purpose of the device.

If the foot-valve strainer clogs, the float is dragged to the bank by the hose, the strainer serviced, and the weight or anchor balanced on the end of one of the float timbers until the hose end is again placed where desired. A jerk on the hose dislodges the anchor, and the raft is again fixed in position.

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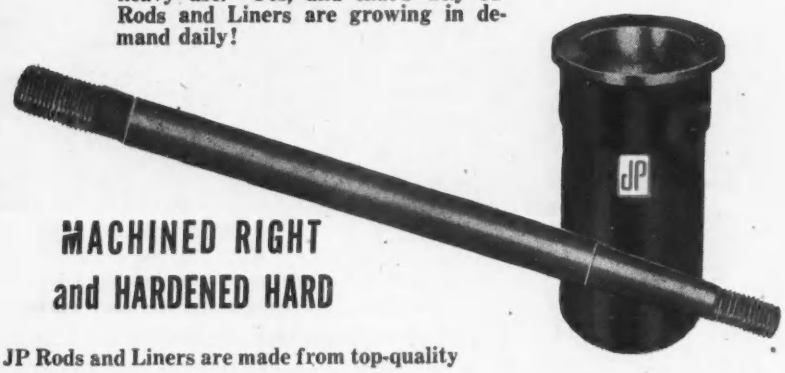

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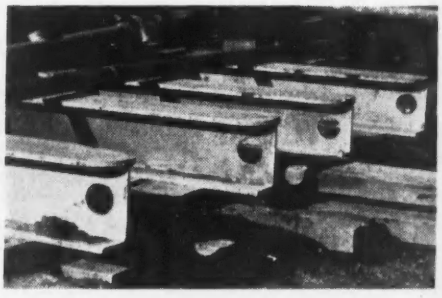
How To—Reduce Rig Accidents

The sharp corners at the ends of I-beams used to provide extended footing for derrick substructures have been the cause of serious leg injuries to drilling personnel. One drilling contractor reduces the accident hazard at this point by having the upper flanges of the beams rounded smoothly, so that no sharp edge is left. The curve is evenly ground, so that no snag remains to catch overall legs.

This rounding of corners is carried through all beams which come at or near ground level, so as to be sure and clear all walkways.

In the illustration of beams so safeguarded, the plank which normally supported the ends of the beams was pulled away, so that the square corners at the base of each beam might be better compared with the smoothly rounded upper flange ends. Holes shown in the ends of the beams are for winch line hooks or bars, for easier handling of the units.



Newer Techniques in AERIAL SURVEYING

Part 5

Photographic and Photogrammetric Aids to Field Mapping

By DR. SHERMAN A. WENGERD

NEWER techniques in the utilization of aerial photographs for oil exploration include many simpler aids developed within the last few years.

These simple aids have not found wide use because the oil industry is not given to using half-way measures in photographic mapping. Most oil companies depend heavily upon the excellent aids provided by photogrammetric processes or they use aerial photographs only for pictorial examination of terranes.

Between these two methods of utilizing aerial photographs is a vast field of techniques which can save companies much expense in planning and executing ground exploration ([51]Desjardins—1943, [52]Desjardins—1945). It is axiomatic that the more time spent on office preparation of photographic coverages prior to surface geology, the faster, more efficiently, more accurately, and less expensively field work can be carried out. Two simple time-saving functions can make field work 100 percent more effective; namely, choice of areas for intensive study, and preparation of working base sheets. Whether the geologic features can be interpreted directly from aerial photographs or not, these two aids can be used over all areas. Any geological interpretation which can be done is merely a greater application of the photography over an area amenable to photographic interpretation ([39]Desjardins and Hower —1939).

A surface party in Texas was provided with photographs to aid in the field mapping. The coverage consisted of mounted mosaics in sections at a scale of one inch to 1000 feet. This non-stereoscopic coverage was used to aid the party in finding accessible roads and trails. Much of the time in the field was spent in searching for outcrops. Strict application of stereoscopic photographic technique in the office and the field would have resulted in accurate location of many outcrops and contacts necessary for structural contouring of the area by plane table. Additional time in preparation of controlled mosaics by radial-line triangulation, utilizing the abundant U.S.G.S. control available, would have yielded accurate plane-table base sheets. Their utilization would have reduced field work to getting elevations on contacts by plane table. Further projection of new techniques, using the precise two-base altimetric technique, can reduce field work to a study of surface geology with a minimum of survey engineering in preparation of plane-table planimetric base sheets.

Planimetric Base Sheets and Enlarged Photographs

Areas of low relief may be mapped quickly with plane-table base sheets consisting of photographs enlarged to a definite scale ratioed to abundant field control available from land ownership plats and U. S. Topographic quadrangle maps ([58]Littleton—1944). Horizontal closing errors up to 500 feet were allowed in surface mapping in North Texas. Vertical closing error was limited to 1½ feet. The best graphic realignment and correction of large-loop plane-table traverses having horizontal closing errors of 500 feet often may put certain geologic contact elevations over 100 feet from their true horizontal positions. In prairie grass lands containing outcrops, these measured elevation points may be more than 200 feet from their true horizontal positions. Horizontal position errors of 200 feet in terranes having formation dip of four degrees will result in a vertical error of 14 feet should the direction of closing error coincide with direction of four-degree dip. Closed traverse error which cannot be graphically corrected so that each measured elevation point is within 50 feet of its true geographic position (in relation to all other elevation points) may lead to structural misinterpretations of plane-table mapping in areas where low-relief structural anomalies are present.

The errors are not compensating, and their seriousness depends upon the direction of error in relation to the direction of dip. Photogrammetric standards, for planimetric mapping at scales less than one to 20,000 in which one geographic control point is available for every block of eight photographs radially-triangulated (approximately 6½ square miles of stereoscopic coverage at a photographic scale of one inch to 1000 feet), require 90 percent of all detail points on that planimetric base sheet to be within 1/50th of an inch of their true positions, i. e., 90 percent of all detail must be within 20 feet of its true horizontal position on a map having a scale of one inch to 1000 feet. The accuracy of good radial-line compilation and Multiple-compiled planimetric base sheets is

much greater than the plane-table mapping resulting from ordinary surface work.

If 9x9-inch vertical photographs flown at a scale of 1:24,000 (six-inch lens at 12,000 feet) are enlarged to 1:12,000 one inch equals 1000 feet), plane-table base sheets 18 inches square result. These enlargements may then be placed on the plane table with an acetate overlay. If alidade shots, involving only level determination on the rod, are kept below 2000 feet in horizontal distance, large areas can be covered without recourse to intercept distance plotting. If relief is low, these base sheets may be matched directly and final structural contouring done on overlay acetate sheets or the elevation points transferred to a radially-more accurate geographic relation of all triangulated controlled mosaic to gain a point. If relief is moderate, the points whose elevations are measured in the field may be transferred to the 9x9-inch photographs in the office and an accurate radial-line plot made of photographs covering the surface-examined area. Radial-line triangulation corrects distortions of point positions due to relief and moderate tilt in the photographs. In high relief terrain where the Beaman stadia arc or the vertical circle must be used to compute elevations using the true horizontal distances, the radial-line planimetric base should be used as a plane-table sheet in preference to the enlarged photograph because of relief and possible tilt distortions present in most "vertical" photography.

Simpler Technique

A simpler technique has been devised for use of enlarged photographs with the plane table in cases when only one man is available to do the surface geology of an area ([8]Eardley—1942). The method will work in any type of terrain but requires the added step of completely contouring the photographs in the field by taking rounds of level shots to all points identifiable on the photograph from any different instrument positions. Instrument stations are picked on points readily identifiable in the photographs. Subsequent radial-line triangulation of all photographs so used in the field results in geographic rectification of all measured points and instrument stations. The resulting rectified base sheets then may be used for plotting geology without further alidade work in the field. Where two men are available in rough country, geology and level shooting may be done at the same time with subsequent geologic interpretation from stereoscopic photographs to fill in detail. The end result in all these technique variations is a structural contour map with an accuracy comparable to straight plane-table work and less time spent

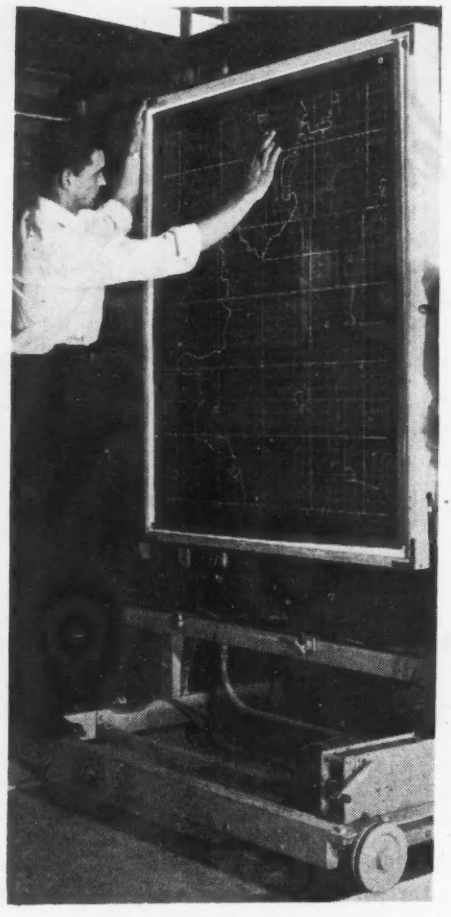


Photo courtesy Kargl Aerial Surveys, Inc., Midland, Texas

FIGURE 8. Completed base sheets compiled from aerial photographs and drafted at a scale of one inch to 4000 feet are placed on a new vacuum easel for copying with a large process camera.

bush-whacking over country which, for lack of outcrops, need not be tramped.

The ideally simple technique for aiding surface geology to be done with plane table is the preparation of complete detailed planimetric plane-table sheets in the office. These may be sent to the field party with aerial photographs to be interpreted directly. A combination of plane-tabling and geologic interpretation in the field and on photographs is a speedy and accurate method of doing surface geology over terranes which cannot be interpreted from photographs alone.

Basic Uses of Photogrammetric Maps in the Oil Industry

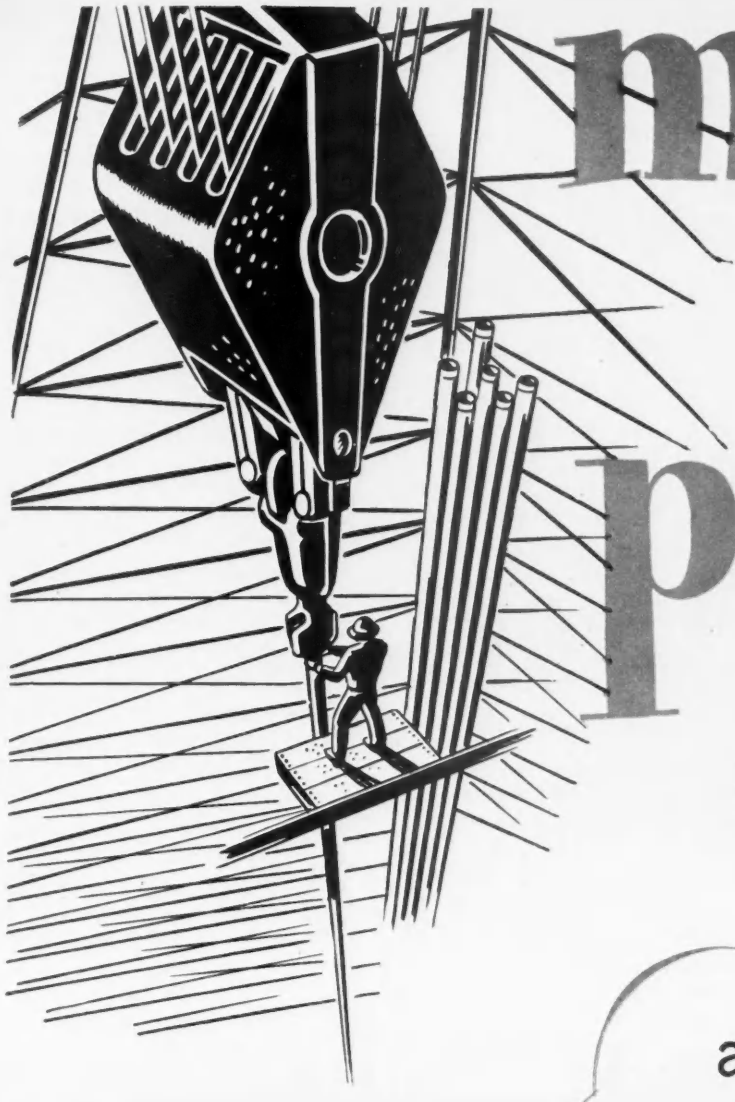
Colonization of America and development of real estate property rights have resulted in thousands of complex land surveys which today are combined to form relatively inaccurate ground survey networks on land ownership maps. In many localities, these maps are inaccurate only in an over-all engineering sense. Land ownership boundaries are well known to the land owners, but their representation on maps is often too inaccurate to plot the correct relations of oil wells ([38]Herzog—1940). This whole system, based on the work of thousands of surveyors, has been tied with gaps and overlaps to the surveys of the General Land Office and early surveys of the U. S. Geological Survey in such a manner that the whole provides an often inadequate guide for oil development in the settled districts of the U. S.

Many maps used by the oil industry today are based on this survey network and often are inaccurately controlled by first and second order triangulation spread out over the continent on the North American datum from the Meade Ranch astronomic determination in Kansas. Areas not obscured by land title controversies and small, separate, interlocking land surveys have required primary mapping which is based on far more accurate techniques now available to the mapping engineer ([39]Whitmore—1936). Over unexplored areas, gaps in first-order triangulation and mapping tied to the North American datum can be filled out in detail by photogrammetric methods, though the land boundaries must be surveyed on the ground. Who is as interested in the location of a critical stream bend in potentially petroliferous areas as the farmer or rancher is in the location of his south tier of sections in relation to the next ranch?

Unclouded by land survey entanglements, the oil company which hopes to explore a South American concession or an Arctic block must locate it on reconnaissance maps and eventually tie it to major political boundaries, but the wealth of inaccurate detail furnished by the old-time land surveyors of U. S. land areas is missing. The only rapid and highly accurate way to survey the internal features of any large unsurveyed block of land is now available through photogrammetric engineering.

The most widespread foreign use of photogrammetric base maps by the oil industry is for the initial exploration of unmapped areas (Figure 9). Such maps are used in planning reconnaissance field exploration and general pipe line routes. A second basic use of aerial photographic maps is for detailed geologic mapping on the ground or on aerial photographs. Base maps for subsurface mapping in the U. S. generally are constructed from intricate compilations of land survey boundaries. New photogrammetric base maps for most of the petroliferous areas of the U. S. now are in preparation or completed. The availability of old land survey compilations has in the past forestalled full development of photogrammetric base maps for developed local fields.

Wider use of newer maps for geophysical exploration in the U. S. probably has been forestalled by the existence of the present land survey compilations and accessibility for land surveying. A new arrangement for plat books,



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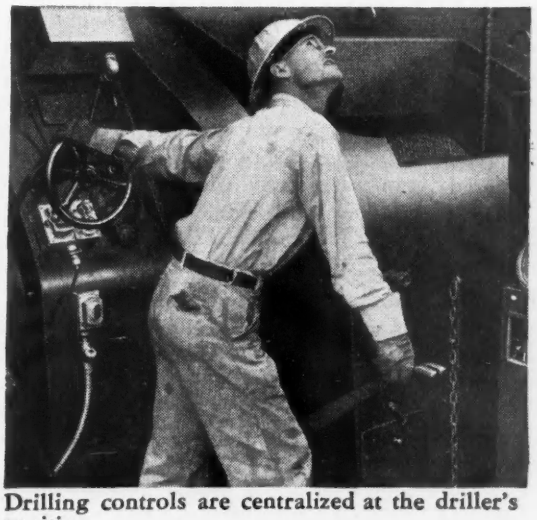

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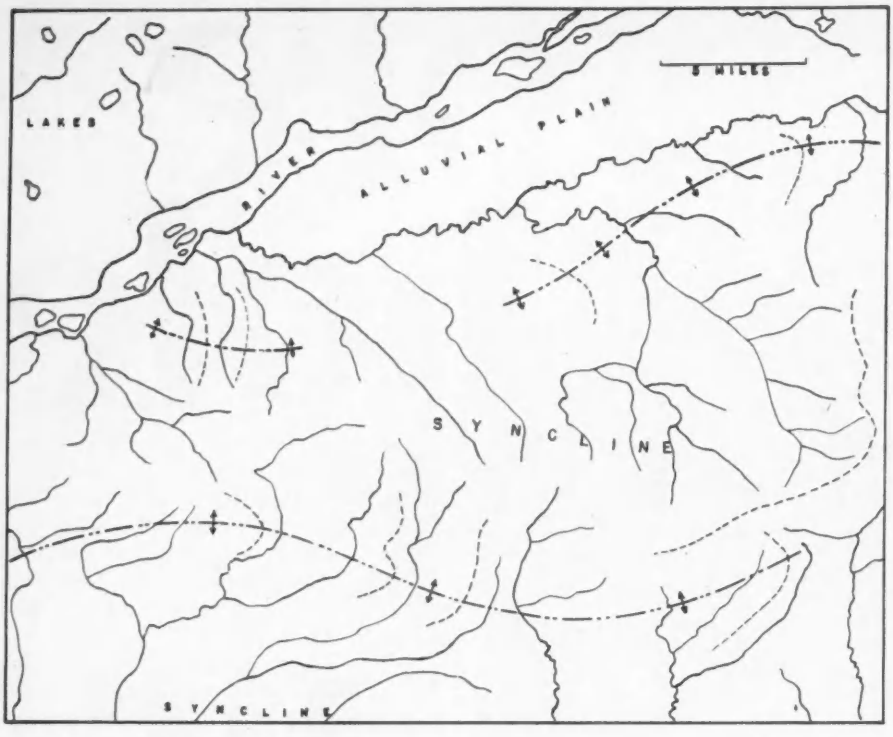

FIGURE 9. Reconnaissance map covering approximately 700 square miles, compiled from Trimetrogon photographs taken at 20,000 feet over difficult Arctic terrain. An example of first-phase reconnaissance geologic interpretation through the use of stream patterns.

using photogrammetric and photographic bases, has found wide acceptance in determining conflicts and vacancies in complex areas of Texas and Louisiana ([96]Boothe—1943).

During the most rapid acquisition of tidal lands in the Pearl Harbor area by the Navy in 1944, a contract survey crew utilized by the Navy was flooded with ground survey work and had a backlog of many months surveying. The Naval Aerial Surveying and Mapping Unit was asked to make large scale photogrammetric surveys of small harbor areas. These aerial photographic compilations were controlled by U. S. Coast and Geodetic Survey triangulation. Land boundaries were checked directly on the controlled aerial mosaics by the Public Works Office of the Navy Department at Pearl Harbor. Land areas were leased and bought on the basis of these controlled mosaics both at Pearl Harbor and in the bomb range areas on other islands. Two months after this aerial cadastral work, the contract crews surveyed the blocks so assembled and the maximum error found was one of only eight feet in the geographic location of one pier pile at the extreme edge of the compilation. Adjustments in the leases were made accordingly but the land areas were utilized by the Navy for two months without waiting on ground surveying during a critical part of the war. The lack of wartime pressures does not necessitate such precipitous applications of aerial photogrammetry to cadastral surveying in the U. S. during peacetime. The cadastral surveyor, in his painstaking job of reconstructing old survey points and lines, is much aided, however, by aerial mosaics in his field work. Final compilation of land surveys into plat books of the type Boothe has devised results in a more efficient representation of land boundaries and the discrepancies between old land surveys and controlled aerial photographic images of the terrain.

Photography has been widely used in in the U. S. by pipe line companies owing to the ease with which suitable and alternate routes can be planned by the use of stereoscopic photographic coverage. Pipe line surveys by aerial photography were used by The Texas Pipe Line Company in 1928 prior to the construction of the line from the Yates pool, Texas, to Port Arthur. By 1938 the cost of pipe line route photography approximated $10 per square mile for flight strips three miles wide over proposed routes. Resulting mosaics and stereoscopic coverage allowed rapid location of pipe lines with a minimum of ground surveying. Flight surveys of the "Big Inch" and "Litle Inch" pipe line routes constructed during the war speeded immeasurably the planning and laying of these lines. Suitability of photogrammetric maps made under wartime duress when these newer techniques were the only way of getting the job done quickly and efficiently has proved the techniques to be accurate. Falling back to the older engineering techniques using only ground surveys for pipe line surveying and exploratory work will prove costly to the industry both in time and money.

Contractual vs. Company Mapping

Application of photogrammetric engineering to the oil industry may be made via several channels. Variations in methods to secure good base maps depend upon oil company finances, long-range plans, size of areas to be surveyed, and final utilization of the maps. In straight contract work, it is customary to furnish several aerial photographic companies full specifications for the aerial photography and the finished maps desired over a particular area. Bids are then submitted to the oil company desiring the maps and the aerial surveying company with the lowest bid is chosen. Several oil companies employ men with sufficient photogrammetric background to act as liaison with the contractors for final checking of the maps furnished. Specifications may call for complete photography, planimetric compilation, and finished topographical maps with the contracting firm solely responsible for the field control and accuracy of photographic coverage.

The oil company which plans a long-range program of aerial reconnaissance may make use of its own aviation department to fly the photographs and may in addition set up a photogrammetric section under the aviation department or the exploration department to furnish final maps of areas which are to be covered. This course has been followed by several large oil companies in South American work. The initial outlay in financing such a photographic and photogrammetric program is sizable if accurate work is to be done. Few large companies have sufficient continuous mapping programs covering long-range developments to warrant acquisition of cameras, instruments, and experienced persnonel to do the job.

An oil company may decide to contract the flying and set up its own photogrammetric section for final construction of maps. This procedure has been used by several large oil companies, especially in foreign areas, Civil engineering departments are usually charged with gaining field control necessary in compilation of the final maps. Lack of experienced photo-geologists and photogrammetric engineers has often deterred a company from planning such a program wisely and carrying it out to a fruitful end. If government photographs are available, as they are over much of the previously unexplored part of the U. S., a photogrammetric and interpretation section may easily be set up and supplied with sufficient instruments to carry out new techniques in precise mapping. The program must be well planned to keep

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such a section continuously busy, for photogrammetric engineers are notable at working themselves out of jobs. Such is the efficiency of these newer aerial photogrammetric techniques. If a company chooses not to set up a photogrammetric section which is to work hand-in-hand with photo-geologists, photographs flown for the government can be turned over to commercial photogrammetric engineers with specifications as to the final maps desired

A final method not yet fully tried in the U. S. or by American capital due to the lack of complete exploration-photogrammetric companies is choice by an oil company of an area which can best be explored from the air with specifications that a complete job of aerial exploration and ground survey be completed, resulting in finished surface geological maps, measured sections, and completed stratigraphical and structural analyses. One aerial survey company is contemplating such an exploration subsidiary for foreign work on contract. A smooth-working group of field engineers, geologists, photo-geologists, and photogrammetric engineers, plus good aerial photographic equipment and flyers should make such an exploration company a financial success.

Recent outstanding examples may be listed which show how several progressive companies have advanced their exploratory and mapping techniques through the use of photogrammetry.

A. *Alberta Foothills belt:* Mapped by a cooperative aerial photographic survey arranged by six major companies; namely, Shell Oil Company, Inc., Gulf Oil Corporation, Socony-Vacuum Oil Company, Standard Oil Company (N. J.), The Superior Oil Company, and The Texas Company. The area of interest had been partly mapped from the air by the Dominion Geological Survey. The joint project mapped the remainder of the area to be explored, approximately 15,000 square miles, at a cost of $80,000. It was the feeling of these companies that "aerial maps afford a good base for reconnaissance and make possible a substantial saving in both time and expense, where more detailed geologic work is intended as a follow-up" ([97]Deegan—1945).

B. *Development of Venezuela blocks:* Several companies carried forward during 1946 large programs of exploration in Venezuela. Because work on ceded blocks must be completed before expiration dates, photo-geological and photogrammetric methods have been used for delineating areas of immediate interest.

C. *Development Exploration of Naval Petroleum Reserve No. 4 in Alaska:* Commodore W. G. Greenman, U.S.N., Captain Bart Gillespie, U.S.N.R., and Lt. Comdr. W. T. Foran, U.S.N.R., as activation officers for initial development of Naval Petroleum Reserve No. 4 in Alaska, early realized the need for applying all possible new techniques in exploring the barren plateaus and coastal plain of the Arctic slope. The 35,000 square miles of the Reserve was a tremendous area to reconnoiter with the short time available to find and drill a potentially petroliferous structure. Early experience of W. T. Foran, as a geologist with U. S. Geological Survey, convinced him that the area contained many structures with good closure and that accurate rapid mapping of these structures could be done only from the air. The writer was called from the Pacific to aid in executing the program of photo-geology and photogrammetric engineering for this exploration, hence the numerous references to Naval Petroleum Reserve No. 4. Trimetrogon coverage flown at 20,000 feet was available, but resulted only in general structural patterns on a 1:100,000 base map. New Trimetrogon coverage was flown at 12,000 feet in 1945, and photo-interpretation by Lieut. N. C. Smith and the writer resulted in accurate delineation of many structures and correlation with data obtained by Naval geological field parties.

D. *Land Maps of Gulf Coast and West Texas area:* Use of a new plat-book arrangement has greatly simplified land mapping on contracts for various oil companies on the Gulf Coast and in West Texas. This application, a precise correlation of ground surveying and aerial photography, has been used by many companies driven to a better means of showing land boundaries on ownership plats. Power companies, flood control projects, county auditors, and the International Boundary Commission have all been convinced of the great savings resulting from more accurate land surveying by careful correlation of land ownership boundaries with aerial photographic maps and mosaic ([96]Boothe—1943). An article published by G. W. Herzog in 1940 summed up the position of one major company on the use of aerial photogrammetry for land survey maps and all types of engineering and photogeology on the Gulf Coast ([100]Herzog—1940). World War II delayed wider development of these techniques on the commercial front.

Choice of areas to be mapped using company facilities, versus contractual mapping of those same areas, depends upon the variables present in every long-range plan of exploration. It is notably true that the contracting aerial survey companies draw to them the most capable photogrammetric engineers because they can keep them busy. Oil companies sometimes employ skilled photo-geologists, of which many are adequately trained in both geologic and photogrammetric engineering, but unsuccessful photographic interpretation programs in many instances may be attributed not to a lack of interpretable detail in the photographs but to insufficient experience on the part of the photo-geologist employed. Those men having abundant field geolologic training, if given a stiff course of photogrammetric engineering, make the most efficient photo-geologists. Until complete aerial exploration companies are set up employing highly trained photo-geologists, the photo-geologic phase of aerial mapping must be handled by oil and mining companies or through consultants.

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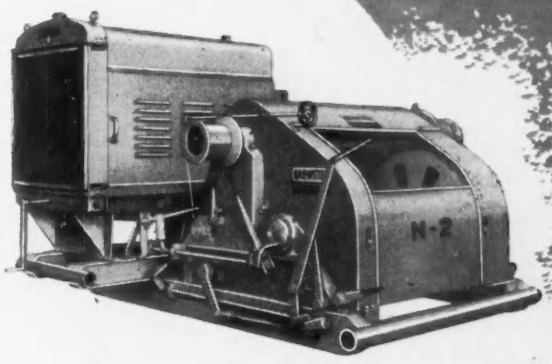

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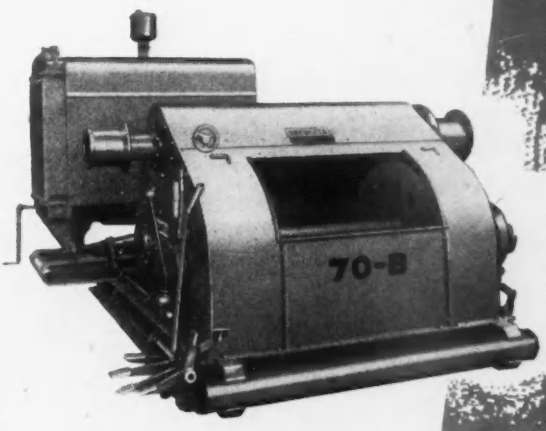

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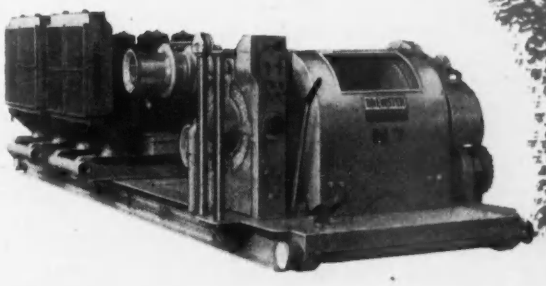

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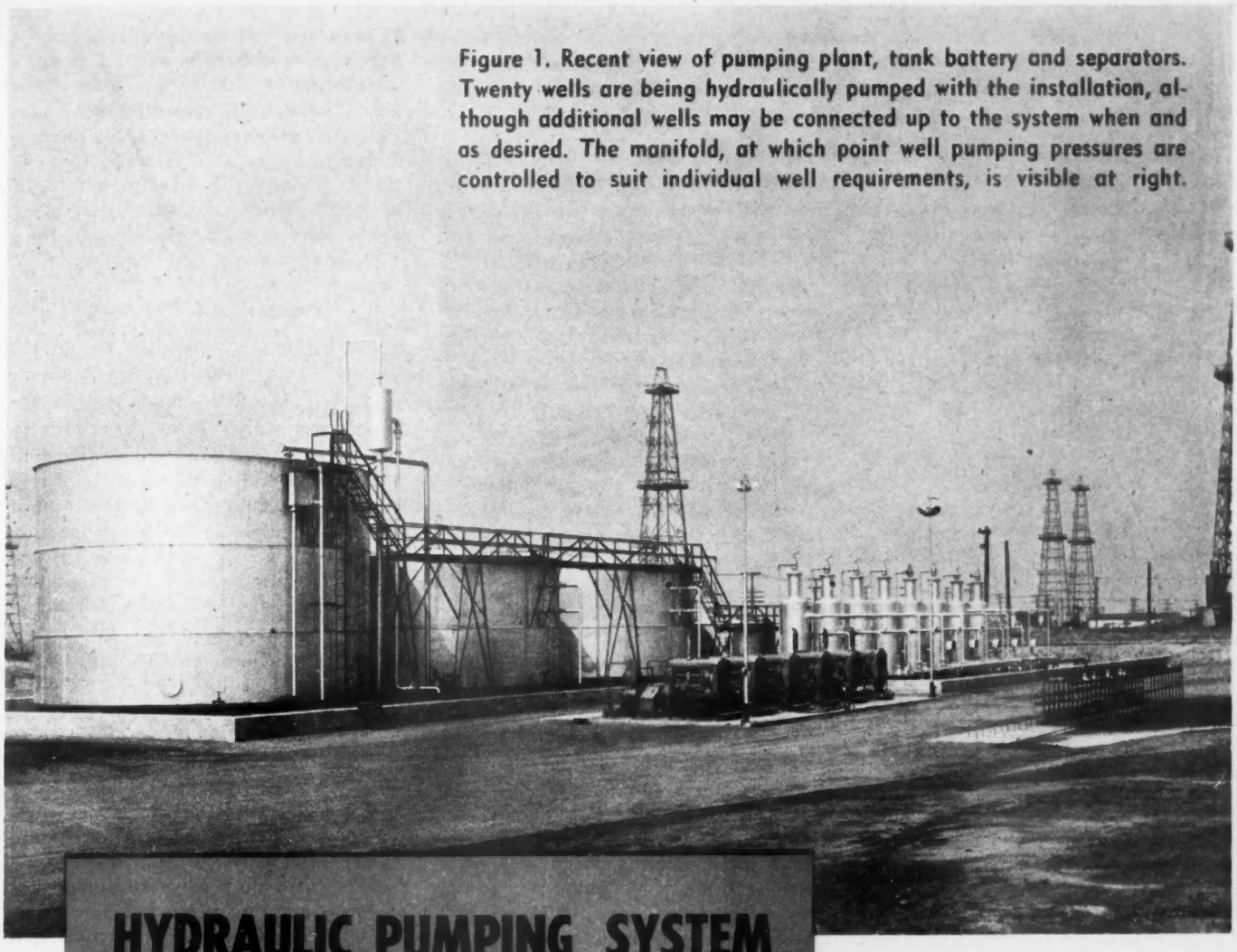

Figure 1. Recent view of pumping plant, tank battery and separators. Twenty wells are being hydraulically pumped with the installation, although additional wells may be connected up to the system when and as desired. The manifold, at which point well pumping pressures are controlled to suit individual well requirements, is visible at right.

HYDRAULIC PUMPING SYSTEM In Lease Re-Equipping Program

By GILBERT M. WILSON
Staff Writer

IMMEDIATE savings in operating costs, reduced upkeep expense and simplified operation are but a few of the advantages being realized on a lease in the Dominguez oil field, located in the Los Angeles Basin, following execution of a long range program of progressive replacement of pumping units with a centrally-located, hydraulic pumping system. The Reyes lease, jointly owned by Union Oil Company and Shell Oil Company, Inc., has production from several zones; the wells currently being re-equipped are producing from depths ranging from 3400 to 6200 feet. Production rates vary from 40 to 200 barrels per day per well, with water cuts ranging between 0.2 and 82 percent.

A group of 17 wells was chosen for the initial installation and others are being added as additional wells in the lease cease flowing or are taken off artificial lift. Very little work is involved in the changeover and addition of new wells to the central pumping plant, for such an operation requires only the setting up of increased pumping capacity at the central plant to supply power for the new wells. Approximately 27 wells are contemplated for the present system, although the flexibility of the installation would permit the addition of more units if needed.

Complementing the power plant and well manifold system in efficiency and flexibility of operation are the wash tank and settling tanks which have been operating with an unusually high degree of success. These installations are shown in Figure 1. Also included in the facilities for handling the produced oil and gas are a trap system and manifolded oil and gas metering system which is practically fool-proof in its operation.

The re-equipping project and plant installation, under way since 1946, was de-

REHABILITATION of older leases, including the removal of old pumping units and equipping each well with lifting equipment having lifting capacities especially designed for the individual well, is a practice gaining momentum in certain Pacific Coast areas. On one lease in the Dominguez field, where wells vary considerably as to production rates, water cut and pumping depths, a deep well hydraulic pumping system was installed on an initial group of 17 wells.

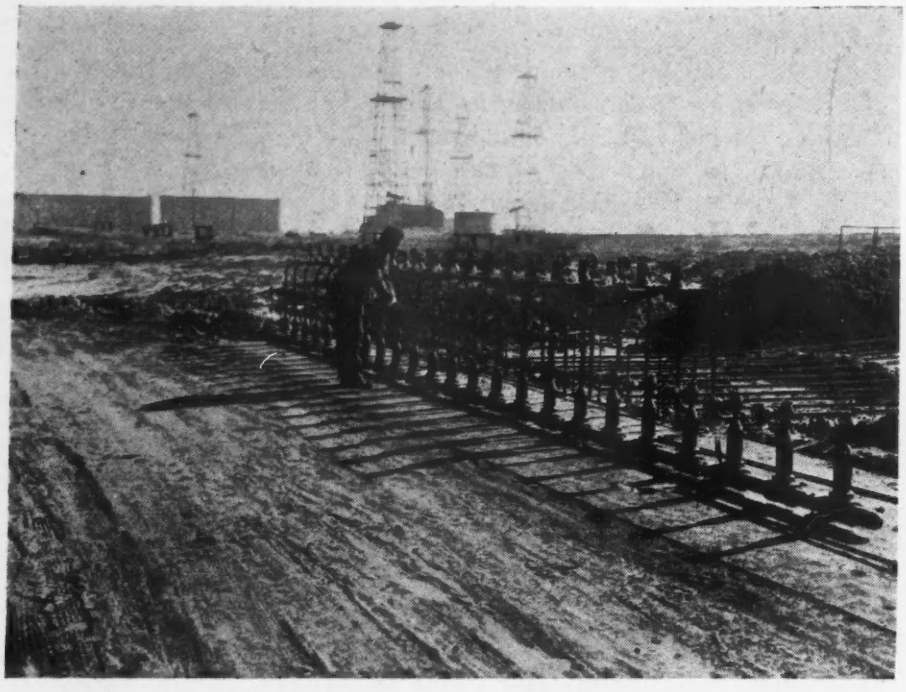

FIGURE 2. Hydraulic pressure needed at each well is closely regulated at this easily accessible, centralized manifold. Pressure gauge and fluid meter indicate pressure and quantity of fluid going to each well. Strokes per minute of the subsurface pump and certain other operating characteristics readily may be obtained for each well through proper interpretation of the pressure gauge fluctuations.

signed by the mechanical engineering organization of Shell Oil Company, which operates the property. The initial installation was a group of wells which had been pumping with beam and rod equipment, but in need of replacement. Some of these wells, before the changeover to hydraulic pumping, still were equipped with the original wooden standard-end units powered with single cylinder gas engines.

Changeover Costs

Several factors entered into the decision to utilize the hydraulically pumped system on this particular lease. Cost considerations for installing the complete system compared favorably with the cost of replacement with mechanical equipment. However, because of the wide variation existing in depths, production rates and water cuts, equipping the wells with individual pumping units would have meant the installation of numerous sizes of equipment and prime movers. On the present hydraulically pumped system, well-head equipment is identical, requires no concrete foundation, and in addition, when, at a later date other wells are changed over from flowing or gas lift to pumping, little or no additional equipment will have to be installed inasmuch as the central power plant easily can be expanded to provide what additional power may be needed.

Changing over a well to pumping, assuming sufficient power has been made available at the central plant, can be made within a 24-hour period. In fact, on a typical changeover job on a standard-end equipped rig, the well need not be off production for more than approximately 16 hours. In that period of time rods are pulled, pump and macaroni string for hydraulic pumping are run in, the well hooked up to the central plant, wooden derrick thrown over and burned, location graded, and a prefabricated cellar of concrete slabs installed.

Horsepower requirement for the first 17 wells were estimated at approximately 100, so three 40-horsepower triplex units were installed initially, space for additional units being provided when the concrete slabs were poured. Six engines and triplex pumps now have been installed, supplying power for a total of about 20 wells, some of the latter being as far as one-half mile distant from the plant.

Pumper's Job Simplified

Fluid power generated by the triplex pumps is transmitted to a header where pressure is regulated and held to approximately 2500 pounds per square inch, the amount presently required to maintain operation of 22 wells. From the header, fluid goes to the central manifold (Figure 2) across the roadway from the pumping plant, where it is distributed to each well in the proportion required for the individual well requirement. Pressures of from 1000 to 2200 pounds per square inch are held on the various wells in the manifold, pressures depending upon amount of fluid and from what depth it is produced. Pressure gauge and power oil meter are provided for each well in the manifold.

Complete control of each well is possible from this centralized point, since it is necessary only for the pumper to adjust a small flow valve to change the pressure and rate of input of power fluid to control the rate of production. The pumper need not walk the entire lease to insure efficient operation of the wells, since operating pressures, strokes per minute of the subsurface pump, and cer-

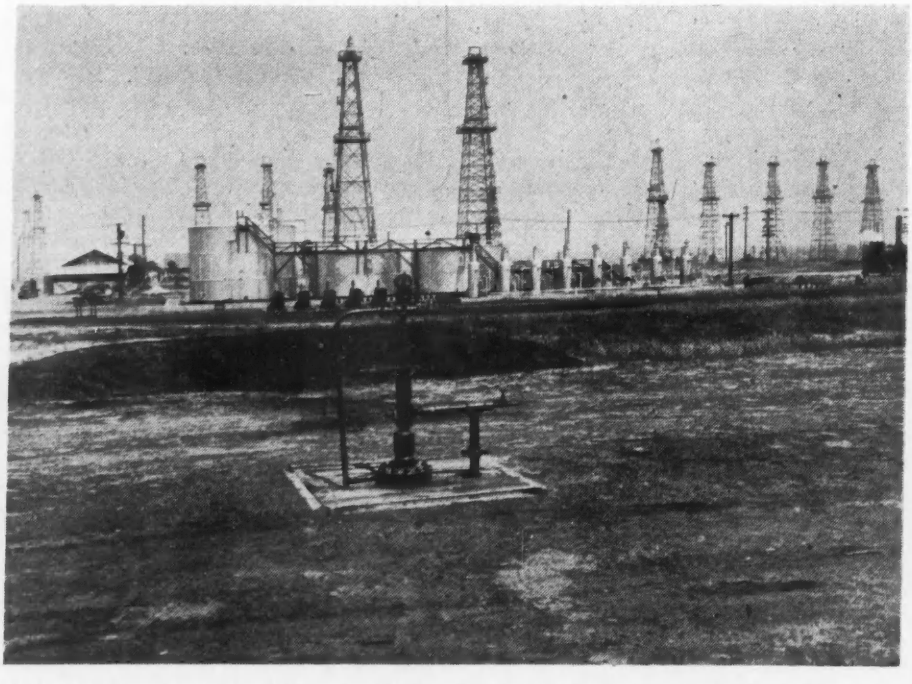

FIGURE 3. View of typical well-head installation. Power oil which actuates subsurface pump enters macaroni string at left, while well production emerges from two-inch line at right and goes over to test trap farm visible in distance.

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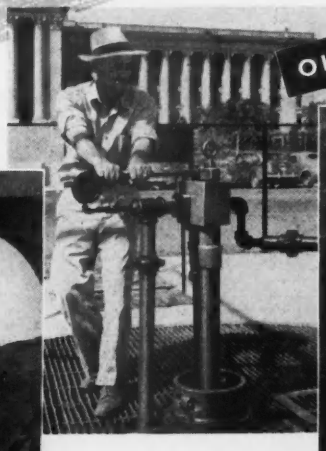
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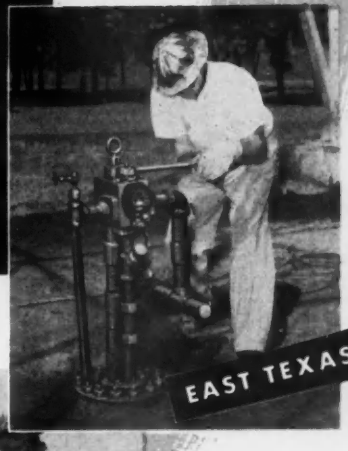
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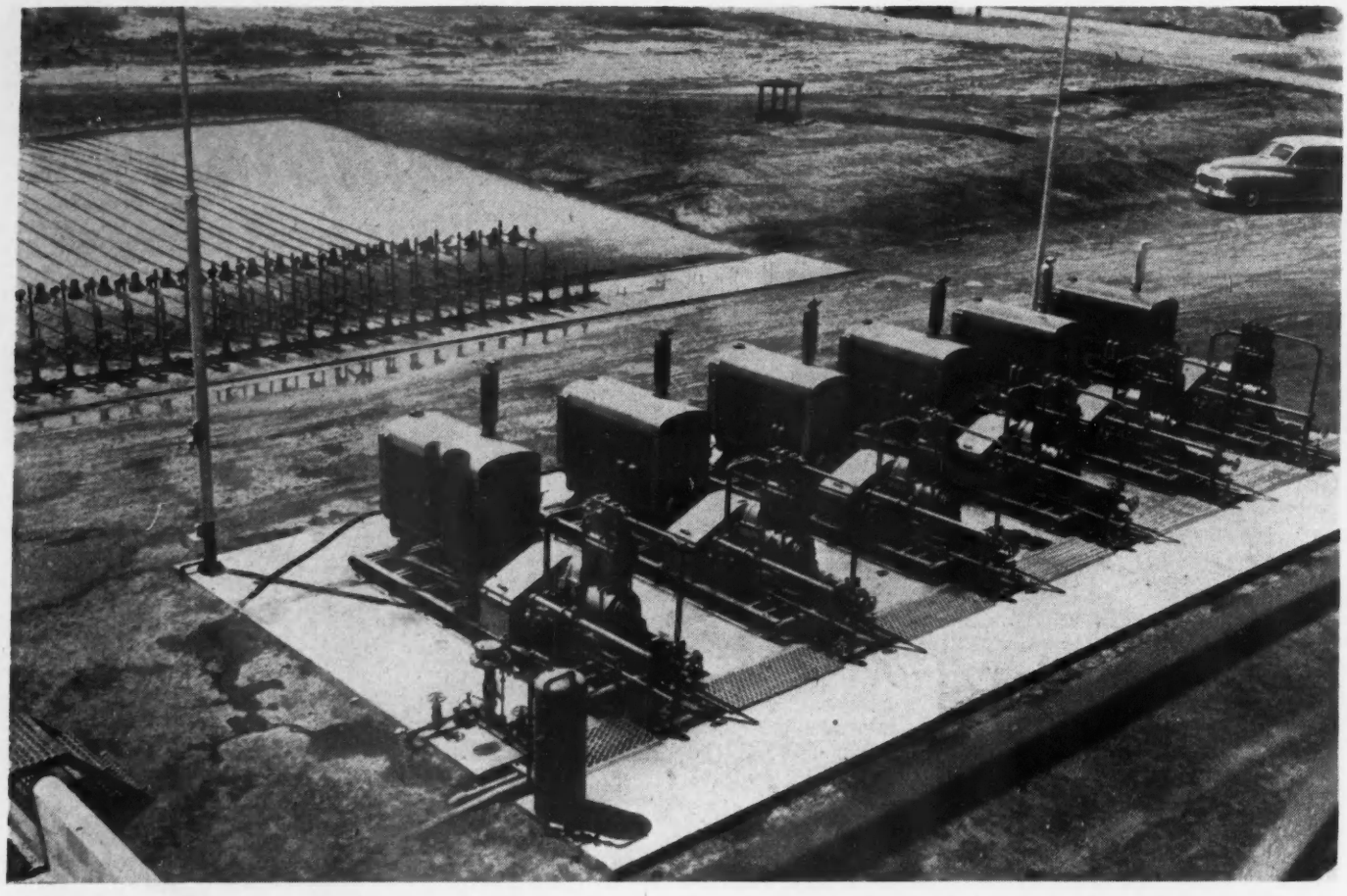

FIGURE 4. The 24-inch thick concrete mat supporting the triplex units is raised several inches above surrounding grade and is provided with an 18-inch grating-covered trench running the full length of the slab. In this trench are laid water, fuel, oil suction and high pressure discharge lines serving each of the units. Complete drainage around the engines is accomplished by provision of a shallow drainage sump, sloped three ways, beneath each unit, collected fluids being drained into the trench, then off to the edge of the slab. Slated for installation soon are supply reservoirs which automatically maintain proper fluid levels in engines of water, lubricating oil and triplex lubricating oil.

tain other operating characteristics readily may be obtained for each well through proper interpretation of the pressure gauge fluctuations. One-inch high pressure lines radiating from the centralized manifold deliver power fluid to each of the widely scattered wells.

The mechanics involved in hydraulic pumping is comparatively simple and probably is generally understood by the majority of field men. Clean crude, used for transmitting power to the subsurface production unit, is picked up from a settling tank by charging pumps which deliver oil to the intake line of the triplex pumps, the latter driven by multi-cylinder gas engines. Power oil is forced through high pressure tubing, in this instance, one-inch, the most commonly used size, to the well-head (Figure 3). A string of macaroni tubing, to the bottom of which is attached the hydraulic pump, is run inside the standard well tubing string. This inner string conducts the power oil to the engine end of the hydraulic pump. Power oil is exhausted into the tubing and returned to the surface in the annulus between the macaroni and tubing, along with the well fluid moved by the production end of the pump. All fluid is taken through conventional lead lines to the production tanks, the latter generally including a wash tank and one or two settling tanks. The cycle is repeated, clean oil being withdrawn from the settling tank as power fluid, while the excess fluid, or well production, overflows by gravity into stock tanks.

Ratio Pumps

The subsurface production unit is a reciprocating type pump of two principal parts, the engine assembly and the production end assembly. The engine assembly consists of a reciprocating type fluid-driven engine. A four-way, fluid-actuated engine valve functions to direct high pressure oil to one end of an engine plunger while opening the opposite end of the plunger to discharge exhausted power oil outside the pump. In the "standard" pump, the production plunger is the same size as the engine plunger, but in "ratio" pumps, such as are used in some of the wells on this lease, the sizes of the production plunger may vary according to the quantity of fluid to be pumped and depth from which it is taken.

Because of the wide range in pump depth settings and quantity of fluid to be lifted, difficulty normally would be had in holding manifold pressures reasonably similar for all wells, and for this reason ratio pumps are employed. Outside of the variation in sizes of power pistons and production plungers, these pumps resemble the standard pump in every respect.

The standard pump has an engine and production plunger of the same diameter and with the same length of stroke. It has a fluid displacement on the production end equal to the displacement of the engine plunger. Pumping efficiency for the one-to-one or standard ratio pump ranges from 65 to 95 percent, this being illustrated by the fact that on a typical pumping cycle, 1.2 barrels of fluid pumped down will bring up a total of 2.2 barrels. Any pump can be converted to another ratio simply by the substitution of other sizes of plunger assemblies.

Header pressure is easily regulated, either by altering engine and triplex speed or by substituting pump liners of various sizes in the triplexes. A pressure regulator on the triplex header holds the output pressure constant. By close watch of actual well requirements and balancing them with triplex output, a

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minimum of fluid is bypassed back into the settling tank system, with correspondingly lowered costs of operation and maintenance for the pumping plant.

Free-Type Pumping

Still another type of pump employed with considerable success in this system is the "free" pump, a complete unit which is hydraulically seated in the well, or surfaced, without necessity of having to pull macaroni or tubing strings when the pump is removed for repair or inspection. This revolutionary method of "pulling" a well, makes it possible for the pumper to operate a valve on the well-head, and with the normal hydraulic pressure available at the well, bring the pump to the surface where it is caught in a special device.

After servicing or exchanging it for a replacement unit, the pump is re-inserted in the well-head and pumped back down into operating position where it will immediately resume pumping. Use of such a pump permits the well to be serviced by only one man, usually the pumper on the lease, and the job may be completed in a matter of minutes or at most an hour or so, after which the well may be put back on production with total well downtime being almost negligible. Two wells in the particular lease under discussion have been equipped with the free pump.

Pumping of soluble plugs at regular intervals through the production and power oil lines is holding paraffin accumulations to a minimum. Some of the longer lease lines, however, may require some heating during the colder winter months.

Pumping Plant Facilities

The centralized pumping plant contains a number of features that contribute much to the trouble-free maintenance of the installation. Designed to accommodate six triplex units, the 24-inch thick concrete mat (Figure 4) is raised several inches above the level of the surrounding ground and provided with an 18-inch grating-covered gutter running the length of the slab. In this trench, which has a slope of six inches in its 48-foot length, are laid water, fuel, oil suction and high pressure discharge lines, laterals from each of these lines branching off to each of the triplex units. The engine-triplex units, mounted on skid bases, are bolted to studs set in the concrete. Complete drainage around the engines is accomplished by provision of a shallow drainage sump, sloped three ways, beneath each unit. Collected fluids are drained off into the gutter and then off to the edge of the slab. Elevated floodlights at two corners of the setting provide ample illumination for night servicing. In laying out, a 20-foot driveway was left between the engine setting and production manifold, ample room now being available to permit entrance of a large winch truck when repair or removal of engine or triplex units is necessary.

Slated for installation soon are several additional features which will assure constant supplies of water and oil to the six units. Three supply reservoirs, elevated to the proper levels, will contain, respectively, engine radiator water, engine lubricating oil and triplex lubricating oil. Simple float controls to assure a dependable feed will be employed, making it necessary for the pumper only to check fluid levels periodically and occasionally replenish the reservoirs. Assurance that the units have adequate supplies of oil and water at all times, particularly when a pumper may forget to service the plant, will repay may times over the cost of installing such a supply system. In addition, vacuum throttle controls will be installed on each of the engines. Such a control permits the pumper to shut down a unit temporarily for servicing, and in returning it to service, be assured that the throttle will return to exactly the same position as when it was shut down. Such a device will be of considerable value in maintaining discharge pressures at a constant value until a definite change is desired.

Metering and Test Units

Adjoining the central pumping plant is a tank farm consisting of a 3750-barrel wash tank, two 2000-barrel settling tanks, and two small gauge tanks, one of 250- and the other of 100-barrel capacity (Figure 5). In addition, there is a battery of seven gas traps and metering facilities for 24 wells. Unusually efficient arrangement of these metering facilities as well as the method employed in settling out crude oil for reuse as power oil are two most interesting features of the crude handling system.

Incoming crude from the 24 wells, among which are wells now in the hydraulic pumping system, is brought up in individual lead lines to the battery. Here crude may be directed either through daily production test equipment, or into a common line leading to the main dehydrating facilities in another part of the lease.

Of unusual interest from the standpoint of time-saving and fool-proof operation of the gauging and metering installation are the efficiently arranged test traps and flow line manifolds. As shown in Figure 6, the two-inch well flow lines are arranged into four groups of six wells each. Each group has one bulk trap and one test trap, the latter having a recording gas meter and flow meter in the run for the separate gauging of individual wells. In addition, both bulk and test traps are manifolded to permit any well or group of wells being turned into either the 250- or 100-barrel test tank, depending upon size of the well being tested, for check gauging. Fluid also may be directed into the power oil wash tanks, or, as mentioned above, into the main trunk lines leading

FIGURE 5. Aerial view of entire centralized pumping plant, showing compact arrangement of triplexes, manifold, tankage and gauging facilities. In the foreground is the 3750-barrel wash tank; beyond it are the two 2000-barrel settling tanks; then a 250- and a 100-barrel gauge tank. Efficient plant layout permits trucks to drive up on either side of the triplex island.

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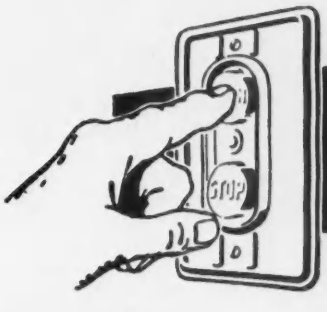

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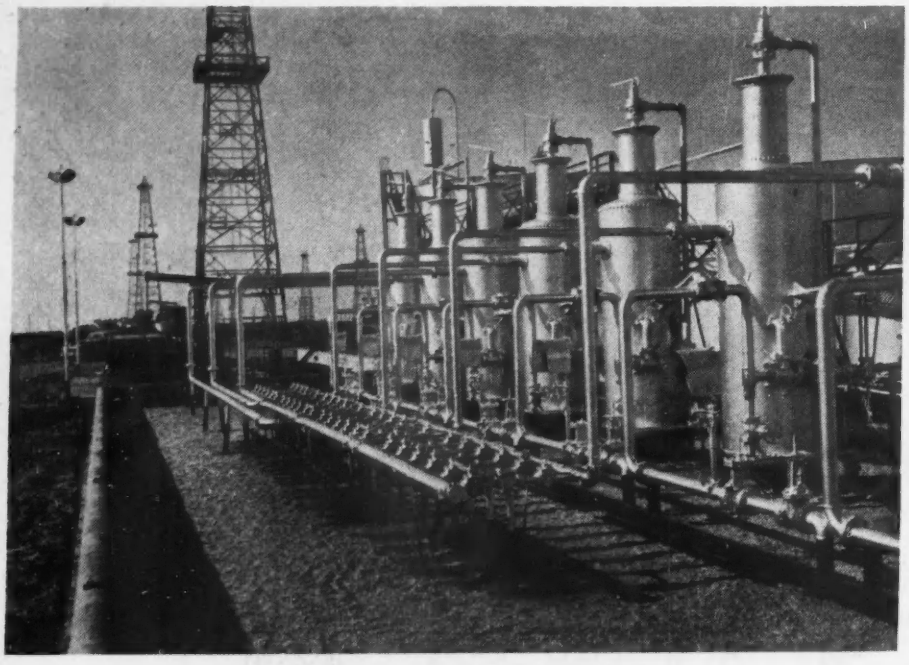

FIGURE 6. Two-inch well flow lines in the efficienctly arranged test trap and flow line manifold are divided into four groups of six wells each. Each group has one bulk trap and one test trap, the latter equipped with a recording gas meter and flow meter in the run for the separate gauging of individual wells. In addition, both bulk and test traps are manifolded so as to permit any well or group of wells being turned into either the 100- or 250-barrel test tank.

to other dehydrating facilities on the lease.

Weekly Gauging Schedule

The method employed for gauging individual wells is ingenious. Each well may be scheduled for a test run on any day of the week, and the grouping of the manifolded outlets is such that the pumper can keep his records straight with little or no difficulty. Taking one of the six-well manifolds (Figure 7) as an example, the routine to be followed by the pumper is to turn the first well in for gauge on say, Monday, the second well on Tuesday, the third Wednesday, and so on until all six wells have been individually gauged. On the seventh day, any well in the group may be turned in for a rerun or any other checking that may be desired. On the following Monday, the first well in the manifold again is turned in, the cycle being repeated each week. At a glance, the pumper can tell which well is on test by noting the handle positions of the plug-type valves. Oil and gas from the well under test passes through the test trap for that group, and the separated fluid and gas are metered and gauged. Production from the other five wells not on test in a particular group is directed through the common manifold and then to any of the several tanks or trunk lines described above.

Simplified Connections

All piping and connections in the test well manifolding are of the grooved coupling type and are so assembled that additions to existing groups of flow lines or meter runs may be made with little change of piping. All manifolding was arranged so that it can be determined at a glance which line goes where; which wells are on gauge; and into which system bulk oil is being directed.

An ample supply of power oil for the central pumping plant is assured with the unusually efficient wash system employed in the 3750-barrel wash tank and the two 2000-barrel settling tanks. Wet fluid from the gauging facilities arrives at the wash tank through a four-inch wash line, and on up to the top of the 25-foot high tank, where it passes through a gas boot, vented into the top of the tank. Fluid drains down through an eight-inch line outside the tank and enters at a point about 12 inches from the bottom of the tank where it flows out on over a spreader pan. Measuring 2 by 3 feet, by 6 inches deep, and made of 14-gauge steel, the spreader is perforated with ½-inch holes cut out on four-inch centers both ways. The unit stands on four sucker rod legs, the latter having cup-shaped glass insulators on the bottom to prevent direct contact of the steel legs on the tank bottom.

The water-oil interface in this tank is held within a range of approximately four feet from the top and is regulated by an unusually simple and easily adjustable short water leg. Unlike many types of water legs, this installation requires no lifting of heavy or awkwardly handled legs, which, in many instances, either are propped up or suspended outside the tank. A rectangular overflow box, shown in Figure 8, measuring 2 feet, 4 inches wide, 3 feet, 2 inches high, and 9½ inches deep, was fabricated from 12-gauge tank steel and bolted to the outside of the tank so that the top of the overflow tank was within a foot or so from the upper edge of the tank top. Inside the tank was mounted a 3- by 18-inch overflow swing nipple for regulating the oil-water interface level. The

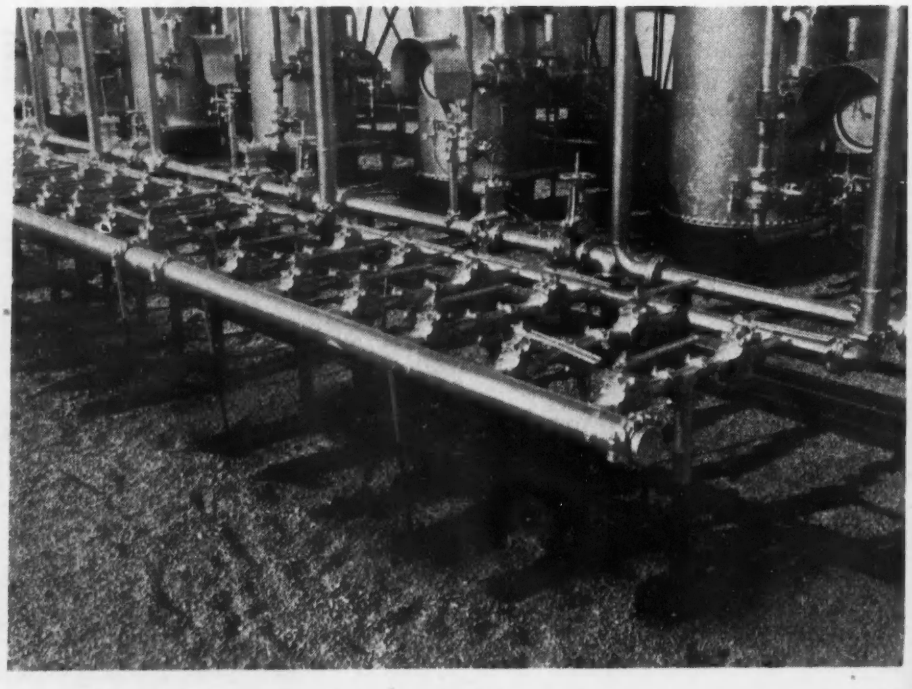

FIGURE 7. Ingenious in design is the system employed for scheduling test runs of individual wells on any day of the week, a method which eliminates much of the possibility of error in test run records. In each of the six-well manifolds (one of which is pictured above), a typical routine for the pumper is to turn the first well in for gauge on say, Monday, the second well on Tuesday, etc., until six wells are gauged. On the seventh day, any well in the group may be turned in for rerun or any other checking desired.

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nipple is adjustable for overflow level by means of a 4-foot steel rod that is easily manipulated by the pumper or gauger from the nearby ladder or platform. A four-inch outside line conducts water from near the bottom of the tank up into the bottom of the overflow box. A three-inch water outlet, connected to the base of the overflow swing fitting, conducts waste water into the waste line. Cleaned oil, taken off at the top of the wash tank, ranges from 0.3 to 0.6 percent water cut.

Power Oil from Settling Tanks

Oil taken from the top, back side of the wash tank, is conducted through a three-inch line to either of the settling tanks. Here the fluid enters at a point near the bottom of the tank on the back side and again passes over a spreader pan. Rising velocity of the fluid in the settling tank is based on a 24-hour settling period; in other words, incoming oil rises at the approximate rate of 16 feet per 24 hours. Power oil, at this final stage in the settling-out process, is taken off with less than 0.1 percent water cut. The cleaned oil is drawn off from either of two outlets three feet apart, the upper one being three feet from the top of the tank. Ordinarily, power oil is taken off through the upper outlet, volume being sufficient for routine pumping operations. However, should the pumping system be shut down for any appreciable length of time, and all units then started up simultaneously, partially drained power oil lines would require more oil at the start, in which case suction is taken temporarily from the lower outlet until such time as makeup oil again brings the tank level up to the upper fitting.

Only sufficient clean oil enters the settling tanks to supply power oil for the hydraulic units, the remainder of the power oil being discharged into the main oil lines. This is accomplished by an ingenious arrangement of an overflow goose-neck on the downstream side of the settling tanks which maintains a constant level of oil in the settling tanks and bypasses the excess oil. Efficiency of the settling tanks is thus increased as the rising velocity of oil is governed by the amount of power oil used from the tanks, and not by the total clean oil production. The small amount of water that accumulates in the bottom of the settling tanks is bled off periodically.

The entire pump setting, tank farm and fluid metering facilities reflect considerable forethought in planning and design. In addition to the advantages found in the conveniently located position of the pumping plant and power oil distributing manifold in relation to the roadway, features within the tank farm improve the appearance and efficiency of the installation. All tanks are mounted on eight-inch high rock-filled bases. A small sump was designed to take drainings from every meter, trap and tank in the system. Five feet deep, the sump is covered at ground level with steel grating and collects by gravity from all drainage lines.

Cement Block Wall

Unusual economies were made in building the two-foot concrete retaining wall that surrounds the tank farm. Designed to comply with laws which specify the minimum net volume that must be included within the enclosure, based on size and type of tanks concerned, the wall was built of concrete block which rest on an 18-inch wide by 6-inch thick concrete base. The 8x8x16-inch blocks, stacked three high and reinforced with sucker rods set vertically in the concrete base and spaced at 32-inch intervals, form a strong, serviceable wall which has several advantages over the usual type of earthen wall faced with oil or concrete. A rounded cap of cement was run along the top of the wall. Inside the enclosure the surface of the ground was covered with clean white crushed rock. This surfacing is practical from the standpoint of drainage and reduced maintenance as compared to a packed earth surface on which puddles of water or oil can accumulate.

Due largely to the planning and design put into the entire plant, originally estimated costs have been reduced substantially and subsequent maintenance costs have been held at low levels. Despite the wide range of pumping conditions to be found in the field and under which the wells are being pumped, only four wells have had to be pulled since the first units were installed in June and July, 1946. That the wash tank and settling system is functioning efficiently is proved by the fact that no repairs to date have been made on the power end of any of the hydraulic pumps.

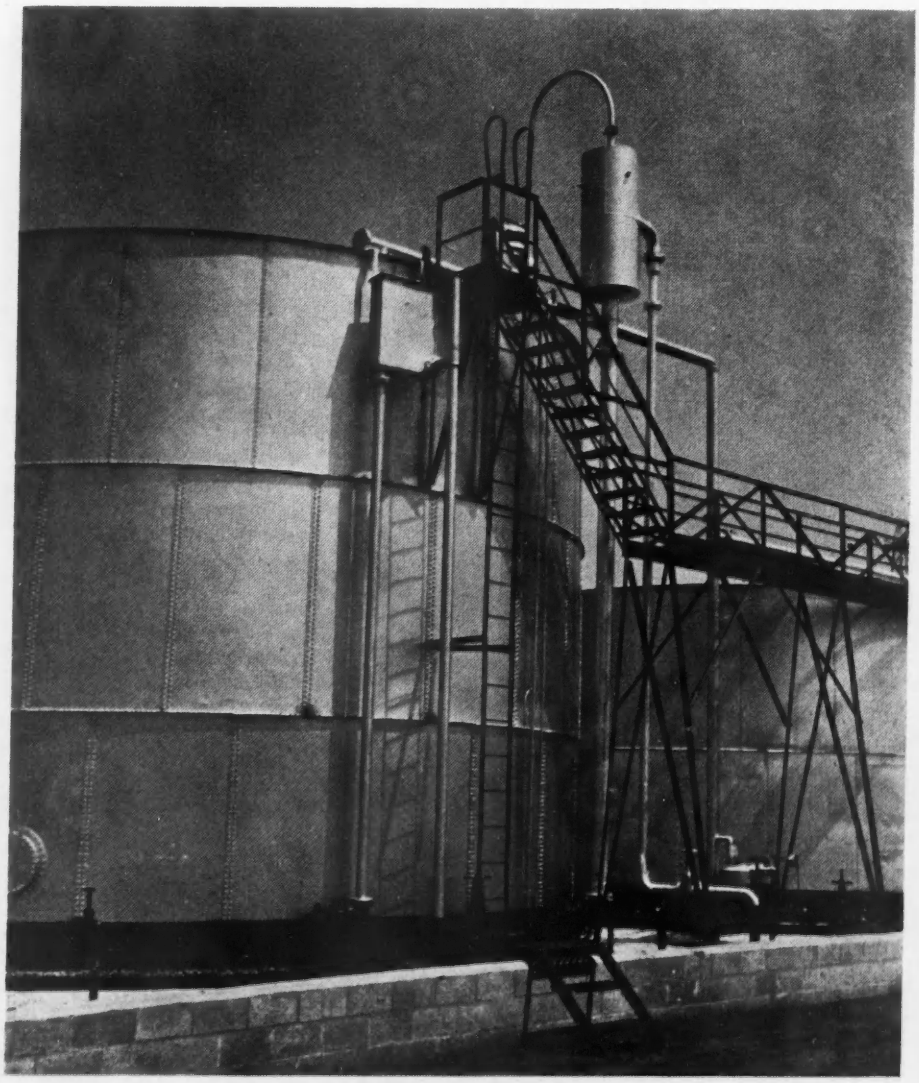


FIGURE 8. The water-oil interface in the wash tank is held within a range of approximately four feet from the top and is regulated by an unusually simple, easily adjustable water leg. The leg is operated within the rectangular chamber shown at the top of the tank near the top ladder platform. Movement of a short steel rod permits the pumper to closely regulate overflow of waste water into the lease waste line.

A SURVEY OF DUAL COMPLETIONS

A SURVEY has been made of the operators in the area included in the API Southwestern District of the Division of Production to determine the trend in the number of dual completions being made, as well as the opinion of the operators on the advantages and disadvantages of dual completions. This survey was made as a part of the study by the Production Practice Committee on dual completions. The almost unanimous opinion of the operators was that the dual well has no advantage over the single completion from an operating viewpoint, and that all of the advantages are either directly or indirectly related to the cheaper initial cost of development.

By E. B. MILLER, Jr.

IN THE spring of 1942, the Southwestern District of the Institute's Division of Production agreed to confine the committee activities in direct support of the war effort. The Topical Committees on Drilling and Production Practices jointly undertook a statistical survey of data on multi-zone completions, which were detailed in a progress report by I. W. Alcorn and W. A. Alexander at the 23rd annual meeting in Chicago in 1942.

Since that time the Production Practice Committee has continued the project, and has recently made surveys of the area included in the Southwestern District. This committee's work was to study the advantages and disadvantages of dual completions; to review their history for the past several years; and to establish trends in the industry to determine if operators are making more dual completions on an accelerated basis, or if these completions are being abandoned, and the reason for such abandonments.

Preprint (subject to correction) of a paper presented to a group session on drilling and production at the 27th annual meeting of the API, Stevens Hotel, Chicago, November 11.

Although the data furnished the author do not include every dual completion that has been made, they are considered to be sufficiently broad in scope, and to represent such a large percentage of the operations, that they are believed accurately to reflect the trends in the area studied. The Southwestern District was divided into seven areas, and the information was collected from the operators and regulatory bodies. These subdivisions are as follows: Gulf Coast, Southwest Texas, North Texas, Northeast Texas, West Texas and New Mexico, North Louisiana and Arkansas, and South Louisiana.

During the war, spacing and other restrictions imposed by the regulatory bodies governing the number of wells permitted to definite surface areas was one of the factors which prompted a great many dual completions. The necessity for conserving steel also was one of the principal contributing factors. At the present time there is still a critical shortage of steel; however, the restrictions imposed by the regulatory bodies have been removed, with the exception of certain state requirements which must be met in order to obtain a permit dually to complete a well.

Total Dual Completions

Figure 1 summarizes, by years, the number of dual completions that have been made and reported in all of the sections listed previously herein. A total of 1319 wells was reported as being dually completed during the period 1940-47. It will be noted that, in 1945, a total of 360 wells was dually completed, and that this was the greatest number of any year covered by the survey. There has been a continued decline in the number of wells dually completed, and in the first seven months of 1947 only 104 wells were completed in this manner.

Gulf Coast

Figure 2 illustrates the trend on the Gulf Coast of Texas. During the first six months of 1947 only seven dual completions were made as compared with 69 completions in the peak year of 1944. A great many of the dual completions in the Gulf Coast area were made in fields which were producing from gas and gas-condensate sands, and were con-

About the Author

E. B. MILLER, JR., was born at Sapulpa, Okla., and graduated from the University of Tulsa with a B.S. degree in 1930. He has been continuously with Tide Water Associated Oil Company since 1934, most of the time in the engineering department. From division engineer in the East Texas area, he went to North Texas as production superintendent. He now is chief petroleum engineer in the Mid-Continent division, with headquarters at Houston.

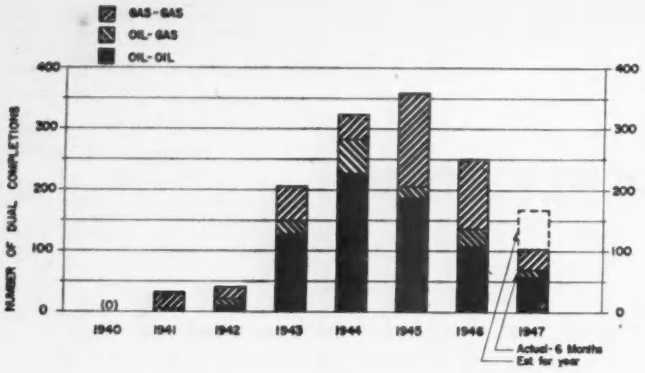


FIGURE 1 (left). Area included in API Southwestern District — total completions, 1940-47.

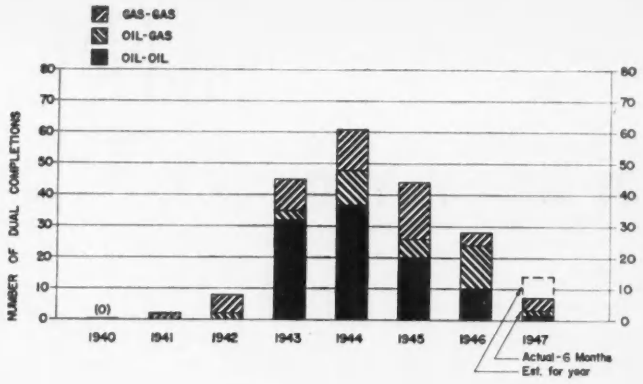


FIGURE 2 (right). Gulf coast dual completions—1940-47.

TABLE 1
Total Dual Completions
(API Southwestern District)

YEAR	Oil-Oil	Oil-Gas	Gas-Gas	Total
1940	0	0	0	0
1941	0	3	29	32
1942	8	13	20	41
1943	128	23	56	207
1944	288	57	40	325
1945	188	19	153	360
1946	107	29	114	250
1947 (6 months)	57	13	34	104*
	716	157	446	1,319

* Actual for approximately 7 months; 168 = total 1947 estimated.

TABLE 2
Gulf Coast Dual Completions

YEAR	Oil-Oil	Oil-Gas	Gas-Gas	Total
1940	0	0	0	0
1941	0	0	2	2
1942	0	2	6	8
1943	32	6	10	48
1944	37	19	13	69
1945	20	6	18	44
1946	10	14	4	28
1947	1	2	4	7*
	100	49	57	206

* Actual for 6 months; 14 = total 1947 estimated.

nected in some manner or other with cycling operations. The extreme corrosiveness of the products produced from these fields has caused failures not only in the tubing but in the casing, and has made it impractical to continue to operate a great many of the wells as dual producing wells. The corrosion has been so severe, and has necessitated such a large amount of remedial work, that most of the wells are now being recompleted as single producing wells. The operators reported 25 wells abandoned as dual wells because of corrosion. Although the fact that a well was dually completed did not contribute to the corrosiveness of the products, it did deny the operator the proper control of the well for efficient as well as safe operation. The injection of chemical to combat corrosion is not practical in a dual well. Inspection of the casing which served as one of the flow strings could not be made, and any failure of either the tubing or the casing made efficient control of the reservoirs impossible. Failure of one zone to flow naturally accounted for the abandonment of 31 wells as dual producers. Of the 206 wells reported as dual completions, 59, or 29 percent, have been abandoned.

Southwest Texas

Figure 3 shows the trend in the Southwest Texas area. In this section of the country dual completions seem to have had a greater degree of continued application than in most any other area. The survey shows that, in the first six months of 1947, 62 wells were dually completed, and that the practice is generally being continued at about the same rate as during the previous years.

It is interesting to note that 147 of the dual completions in this area are on wells producing from two gas reservoirs; and, because the gas is not particularly corrosive, the method is being used frequently. There were 30 dual completions in the first eight months of 1947, which is more than the total for any previous full year. One company, which has approximately 100 dual completions, has found it necessary to rework 23 percent of these wells; however, improvements in completion technique and equipment to eliminate tubing leaks have given the operator reason to believe that it is still practical to continue the method.

There have been 367 wells completed as dual oil wells primarily in the fields which have several thin sands. The economics of drilling oil wells to these thin sands is problematical, and the dual completion of such wells permits the production of the oil from two zones at a slightly higher cost than a single well being drilled to one zone. The very nature of the fields in this area offers the greatest incentive dually to complete wells, and this method is probably more adaptable to Southwest Texas than any other area covered in this report.

North Texas

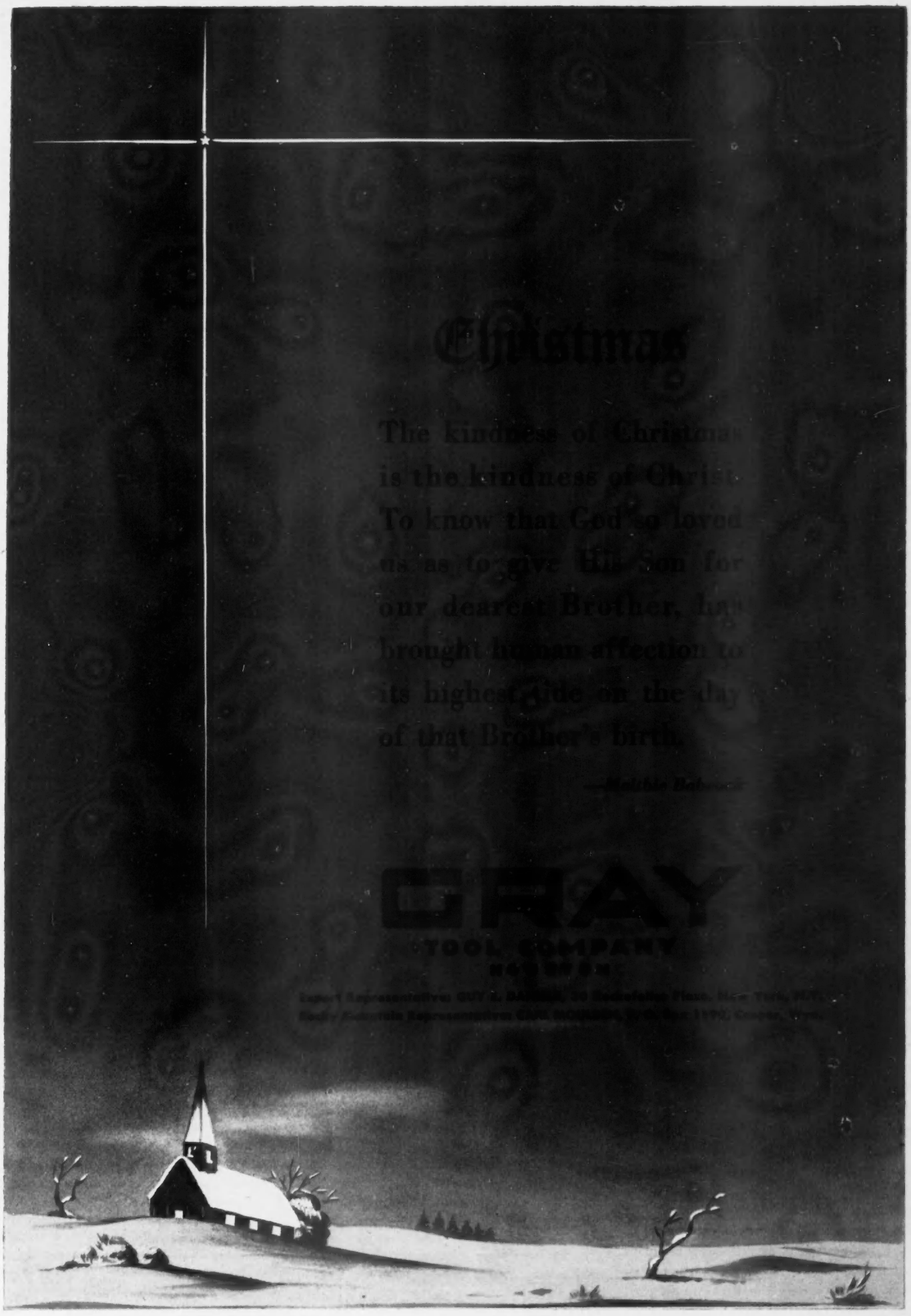
During 1945, a total of 38 dual completions was made in the North Texas area; however, no dual completions have been reported for the first six months of 1947. Of the 105 wells which have been dually completed since 1942, only eight have been reported abandoned. In every case the reason for abandonment given by the operator was that one of the zones had ceased to flow. Most of the wells were completed as dual oil wells, and 57 of the total wells were in the Wimberly Field in Jones County.

East Texas

Due to the development in the New Hope and Carthage Fields in this area, there were 101 wells dually completed in 1945. Of the 32 wells that have been dually completed in the New Hope field, 17 have been converted into single completions because one of the formations ceased to flow. The dual completions were in two oil sands, and very little mechanical trouble was experienced. The dual completions in the Carthage field are in gas sands, and most of them are still in operation. No wells have been reported as being dually completed in 1947.

Arkansas and North Louisiana

Only eight wells were dually completed in this area during the first six months of 1947, compared with 35 in 1944. The largest number of dual wells in Arkansas was in the Dorcheat-Macedonia field, where they met with only mediocre success. Because conditions in this field were most exacting, in that the horizons to be separated consisted of one sour-gas distillate horizon and one


Christmas
The kindness of Christmas
is the kindness of Christ.
To know that God so loved
us as to give His Son for
our dearest Brother, has
brought human affection to
its highest tide on the day
of that Brother's birth.
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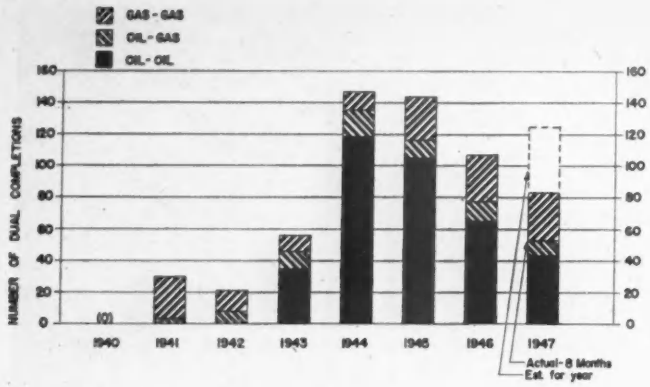


FIGURE 3 (left). Southwest Texas dual completions—1940-47.

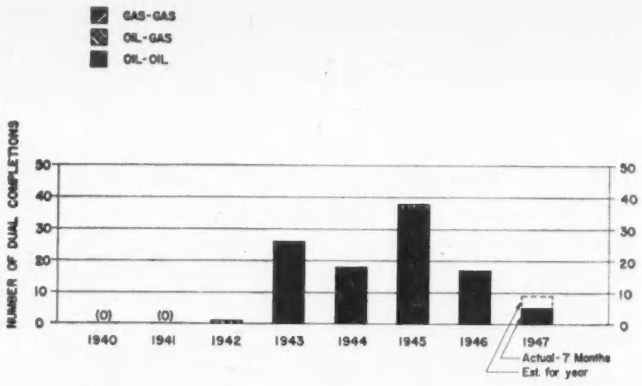


FIGURE 4 (right). North Texas dual completions—1940-47.

TABLE 3
Southwest Texas Dual Completions

YEAR	Oil-Oil	Oil-Gas	Gas-Gas	Total
1940	0	0	0	0
1941	0	3	27	30
1942	0	8	13	21
1943	35	11	10	56
1944	119	17	11	147
1945	105	12	27*	144
1946	65	13	29‡	107‡
1947 (8 months)	43	10	30‡	83†‡
	367	74	147	588

‡ Estimated.
* Includes 2 triple gas completions.
† Actual 8 months; 125 = total 1947 estimated.

TABLE 4
North Texas Dual Completions

YEAR	Oil-Oil	Oil-Gas	Gas-Gas	Total
1940	0	0	0	0
1941	0	0	0	0
1942	0	1	0	1
1943	26	0	0	26
1944	18	0	0	18
1945	37	1	0	38
1946	17	0	0	17
1947 (7 months)	5	0	0	5*
	103	2	0	105

* Actual for 7 months; 9 = total 1947 estimated.

or more sweet-gas condensate or sweet-oil horizons, any leakage between zones was immediately detected; and, because of the large differential in pressure that developed between the zones, numerous packer failures developed.

South Louisiana and Mississippi

There has been a total of approximately 123 dual completions in South Louisiana and 12 in Mississippi since January, 1942. A peak of 46 completions was reached in 1943, and has steadily declined to the present time. One of the major operations in the area reported abandonment of 20 out of 27 dual wells because one of the zones ceased to flow naturally and dual-lift equipment did not prove satisfactory. Corrosion and water intrusion were given as reasons for abanment of a large number of wells producing from two gas zones. The results of questionnaires indicated that 66 of the total of 123 wells, or 53 percent, have been abandoned as dual wells.

The other phase of the committee's survey pertained to the advantages and disadvantages of dual completions as compared to single completions. It is interesting to note that the mechanical failure of the equipment used to make the separation is not one of the principal reasons for abandonment of the operation of the well as a dual producer. The limitations placed on the operator in providing efficient artificial-lift facilities when one or the other zone ceased to flow naturally, and the inability to provide adequate protective measures to combat corrosion, are the two most direct reasons for the abandonment. No doubt these two principal factors, supplemented by other less widespread conditions such as paraffin accumulation, have influenced the operators in making fewer dual completions in spite of the continued critical shortage of steel. There is considerable work being done at the present time on the mechanics of artificially lifting dually completed wells; however, during the period covered by this survey, it is apparent that the successful operation of this equipment had not been demonstrated favorably enough to be received generally by the operators.

The disadvantages of dual completions are listed below; and, although they are not applicable to all dual completions, the list does represent a cross-section of opinions expressed by a large number of operators.

1. Mechanical difficulty of artificial lift when one or both zones ceases to flow naturally.
2. Inability to determine and combat corrosion, particularly in gas wells.
3. More frequent, costly, difficult, and hazardous workovers.
4. Difficulty in obtaining a permanent seal between two producing horizons.
5. Risk of commingling fluids from different zones, both in the well bore and reservoirs.
6. Difficulty in obtaining subsurface data necessary for proper reservoir control.
7. Lack of satisfactory means of removing paraffin from the annulus.
8. Shorter flowing life.
9. Higher lifting costs under certain conditions.
10. Necessity of mudding off one productive zone while reworking another.
11. Less flexible operations.

Advantages

The almost unanimous opinion of the operators was that the dual well has no advantages over the single completion from an operating viewpoint, and that all of the advantages are either directly or indirectly related to the cheaper initial cost of development. The advantages that result from a low development cost are:

1. Makes possible the development of areas where individual zones do not indicate a payout for single wells.
2. Enables the operator to effect the fulfillment of offset obligations without drilling additional wells.
3. Provides both an input and producing well where cycling or pressure-maintenance operations are in effect.
4. Provides two input wells, with one well in cycling projects, where two sands are being processed simultaneously. No corrosion is experienced on injection wells, although the producing wells may show severe corrosion.
5. Development of maximum production at earliest possible date.
6. Savings on expensive marine locations.

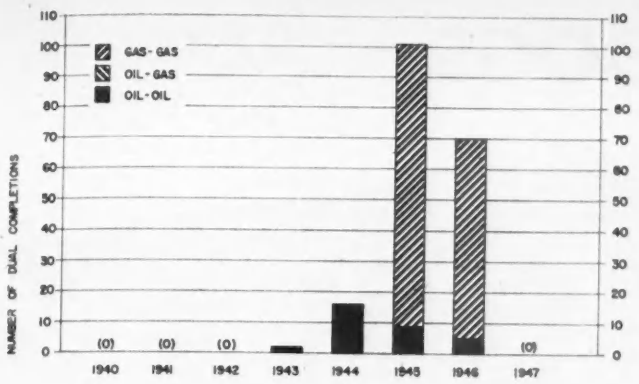


FIGURE 5 (left). East Texas dual completions—1940-47.

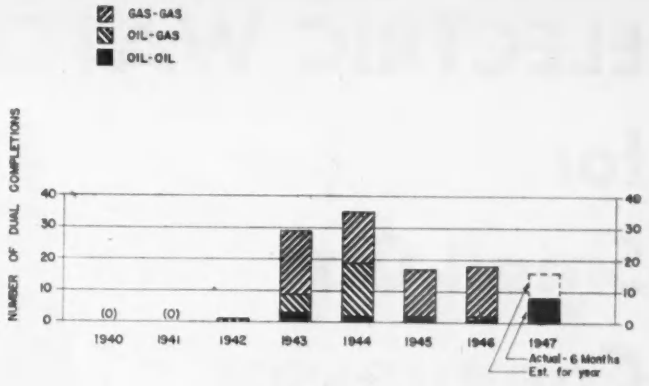


FIGURE 6 (right). Arkansas and North Louisiana dual completions —1940-47.

TABLE 5
East Texas Dual Completions

YEAR	Oil-Oil	Oil-Gas	Gas-Gas	Total
1940	0	0	0	0
1941	0	0	0	0
1942	0	0	0	0
1943	2	0	0	2
1944	16	0	0	16
1945	9	0	92	101
1946	5	0	65	70
1947	0	0	0	0
	32	0	157	189

TABLE 6
Arkansas and North Louisiana Dual Completions

YEAR	Oil-Oil	Oil-Gas	Gas-Gas	Total
1940	0	0	0	0
1941	0	0	0	0
1942	0	1	0	1
1943	3	6	20	29
1944	2	17	16	35
1945	2	0	15	17
1946	1	1	16	18
1947 (6 months)	8	0	0	8*
	16	25	67	108

* Actual 6 months; 16 = total 1947 estimated.

Conclusion

The decline in the number of dual completions made during the year 1946 and the first months of 1947 is of such magnitude that it definitely indicates a trend away from this method of completion. Although these are still a substantial number of dual completions being made, the operators no doubt are taking into consideration the experience gained during the past seven years of operation and are limiting the practice to fields which have the most favorable conditions. The almost unanimous opinion of the operators questioned was that wells could not be dually completed to advantage in all multiple-zone fields, but that there were certain fields in which the practice was feasible from both the operating and economical viewpoint. If the two principal reasons for abandonment, viz., corrosion and cessation of flow, can be used as an index, two of the characteristics which a field should have for dual completions are a long natural flowing life, and fluids which are not very corrosive.

The mechanical separation of the producing zones can be accomplished with the equipment available. However, maintaining this separation has been difficult, especially in fields producing sour gas.

The limitations placed upon the operator in the flexibility of operating dual wells, and especially the difficulties in combating corrosion and artificially lifting one or both producing horizons, are apparently of such magnitude that in a great many fields the savings in initial investment are not enough to justify completing the wells in this manner.

Even though there is a critical shortage of steel, it is the writer's opinion that most operators will be influenced only slightly by this situation, and that field characteristics and operating conditions will be the determining factors in completing wells for dual production.

Acknowledgment

The author wishes to express his appreciation to the members of the committees who were responsible for the accumulation of the data which served as a basis for this paper.

The cooperation of the operators who prepared the questionnaires and expressed opinions is gratefully acknowledged; for, without this cooperation, the study would not have been possible.

Especial thanks are due to the chairman of the Production Committee of the Southwestern District, R. E. Bridges, and to H. L. Kirkpatric, J. H. Ramblin, S. C. Oliphant, Paul Turnbull, E. D. Brochett, Jr., Glenn Staley, and L. H. Dial, who served as chairmen of the subcommittees and were directly responsible for assembling the data in their respective areas.

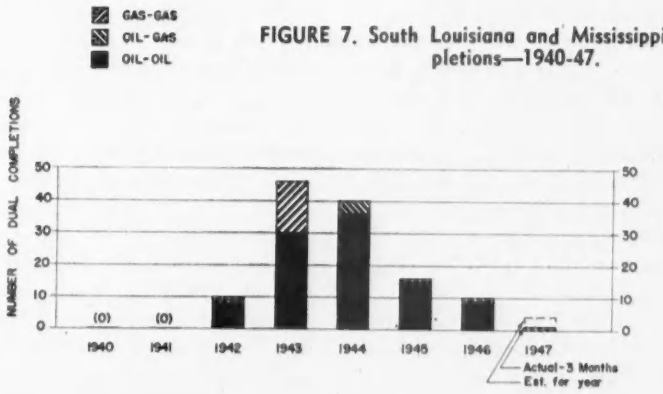


FIGURE 7. South Louisiana and Mississippi dual completions—1940-47.

TABLE 7
South Louisiana and Mississippi Dual Completions

YEAR	Oil-Oil	Oil-Gas	Gas-Gas	Total
1940	0	0	0	0
1941	0	0	0	0
1942	8	1	1	10
1943	30	0	16	46
1944	36	4	0	40
1945	15	0	1	16
1946	9	1	0	10
1947 (3 months)	0	1	0	1*
	98	7	18	123

* Actual for 3 months; 4 = total 1947 estimated.

ELECTRIC WATCHDOGS for Small Gas Compressor

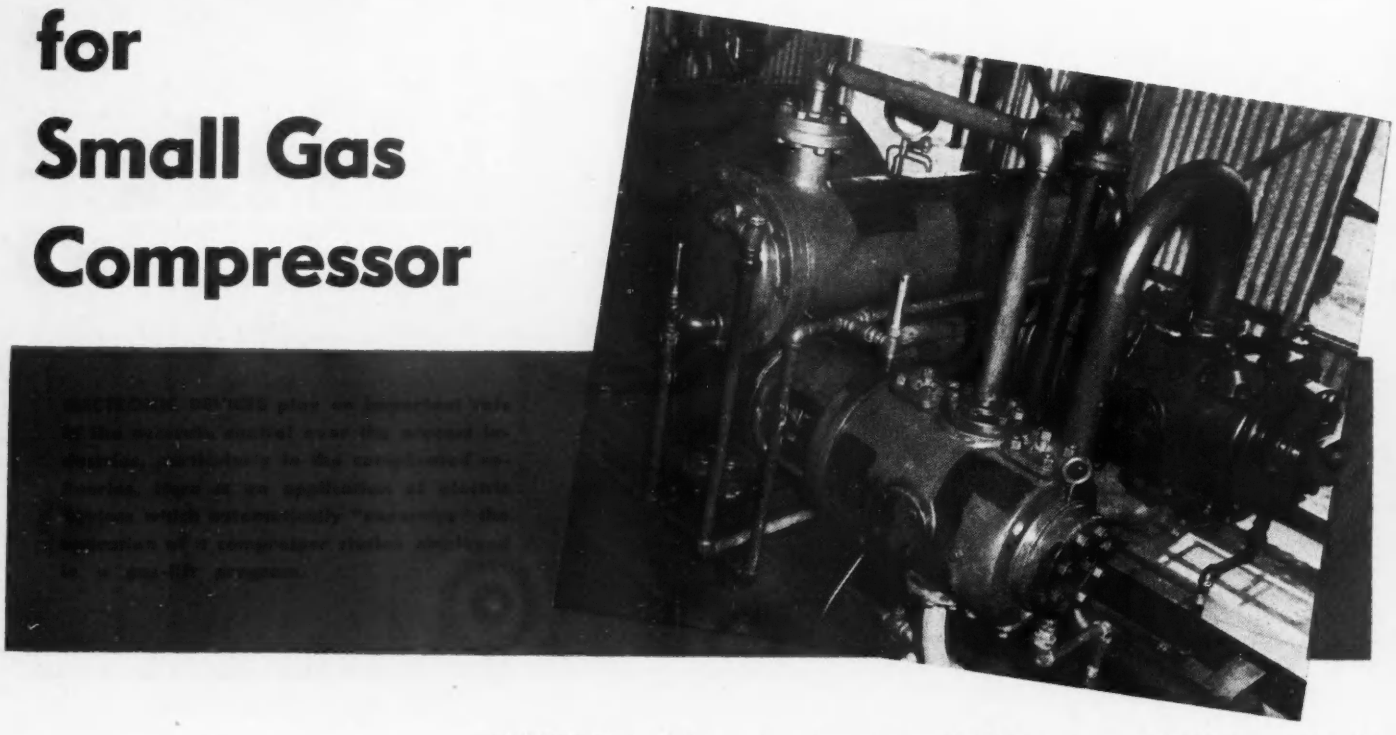


FIGURE 1. Two-cylinder gas compressor in operation for seven years and still giving satisfactory service. Total repair costs: $25. Approximately 400,000 cubic feet of gas are compressed daily to furnish the energy necessary to gas lift four wells averaging 5000 feet in depth.

By J. E. KASTROP
Staff Writer

THE selected application of electric controls has eliminated the human element in the 24-hour-a-day surveillance over a small compressor plant used in gas-lift operations on a lease in the Barbers Hill field of Texas. A careful study of the gas lift requirements on this lease and the proper installation of special control instruments have closely limited the operating conditions of the compressor and its prime mover, a 70-horsepower, four-cylinder, natural gas engine. By maintaining practically constant conditions for both the compressor and engine, and eliminating overloads, the cumulative repair expenses have been held to an exceptionally small figure when compared with the initial investment and the value of work performed.

The limitation of gas scrubber pressure, compressor discharge pressure, engine lubricating oil pressure, engine tempeature, and other safeguards in connection with the compressor operation, have been largely responsible for obtaining maximum performance from the complete unit, now seven years old and in constant operation since its installation in 1940. Repairs over this seven-year period for the compressor have cost only $25. Repair costs for the engine over this same period totaled approximately $1500. These figures do not include the cost of lubricating oil, fuel, cleaning or any expense in connection with the operation and upkeep of the compressor station.

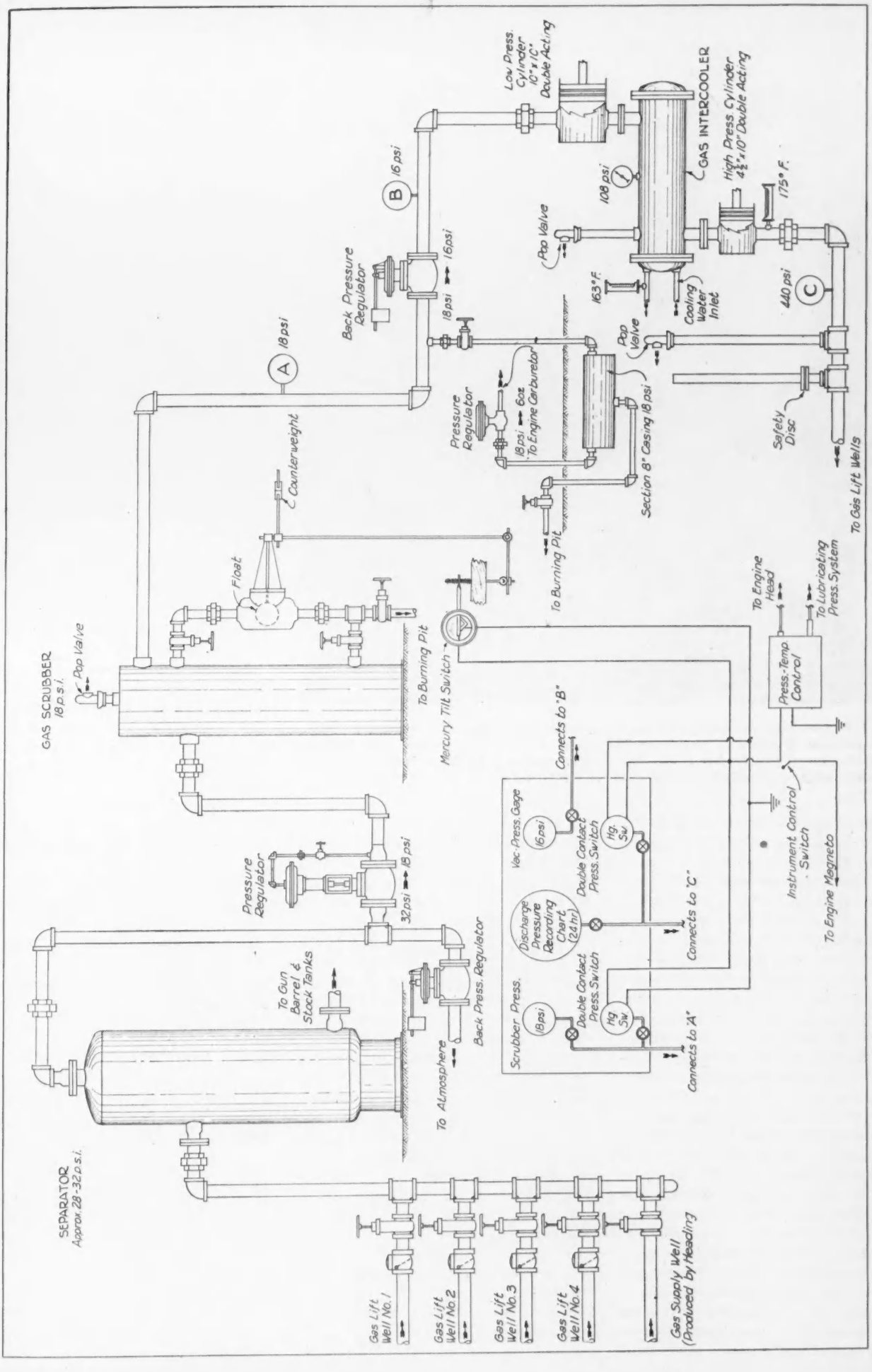
Operation Comparable to Recycling

The complete cycle of events in this gas lift operation is comparable, in part at least, to a recycling program. Gas accompanying the oil is knocked out at the separator and cleaned before entering the compressor. It is compressed and reinjected into the casing annulus of four wells which are produced by gas-lift methods. This gas under pressure supplies the energy to lift the oil from the 5000-foot wells and flow it into the separator. The oil flows into tanks and the separated gas is recompressed and the cycle repeated. The separator pressure is maintained at about 32 pounds per square inch. When the pressure exceeds this value, the gas is flared. Some gas in solution is produced from each of the four wells, and when the fluid surges into the sepaartor, part of this gas is released into the flare. By relieving pressure surges in the separator through a back-pressure regulator on the flare line, some gas is used and must be replenished.

One well on the lease produces from a "finger sand," and is peculiar in that it is a "head" well. Casinghead pressure builds up over an extended period and the well will flow naturally for a short time, only to die completely at the end of the flow. When shut in, pressure builds up again and the well may be made to flow by manual control of the flow line. This well supplies much of the necessary "makeup" gas for the system. This gas is in addition to that which comes out of solution from the oil produced by the four gas-lift wells.

The head well is connected into the flow line manifold at the lease separator along with the flow lines from the other four wells. It is flowed manually when the pressure builds up to a maximum, producing its oil into the separator while the gas accompanying the flow is routed to the compressor. In this manner, the operation is assured of sufficient gas to continue the cycle from one day to the next. This characteristic is peculiar to this lease, and is probably a rare one, but the lease has produced continuously under this method for the past seven years with no indication of letting up.

Approximately 400,000 cubic feet of gas is compressed daily and used in the gas-lift system to produce a daily total of about 260 barrels of oil from the combined four wells on the lease. Pressure maintained in the separator flows the



Diagrammatic sketch of the compressor station showing the flow of gas through the system. Relation of the electrical and mechanical safeguards to the critical points throughout the system are indicative of the precaution taken at each step of operations. These devices actually "feel the pulse" of the station, and when this pulse rises too high or drops too low, the entire mechanism of producing oil by gas lift is stopped. It remains inoperative until the source of trouble is removed.

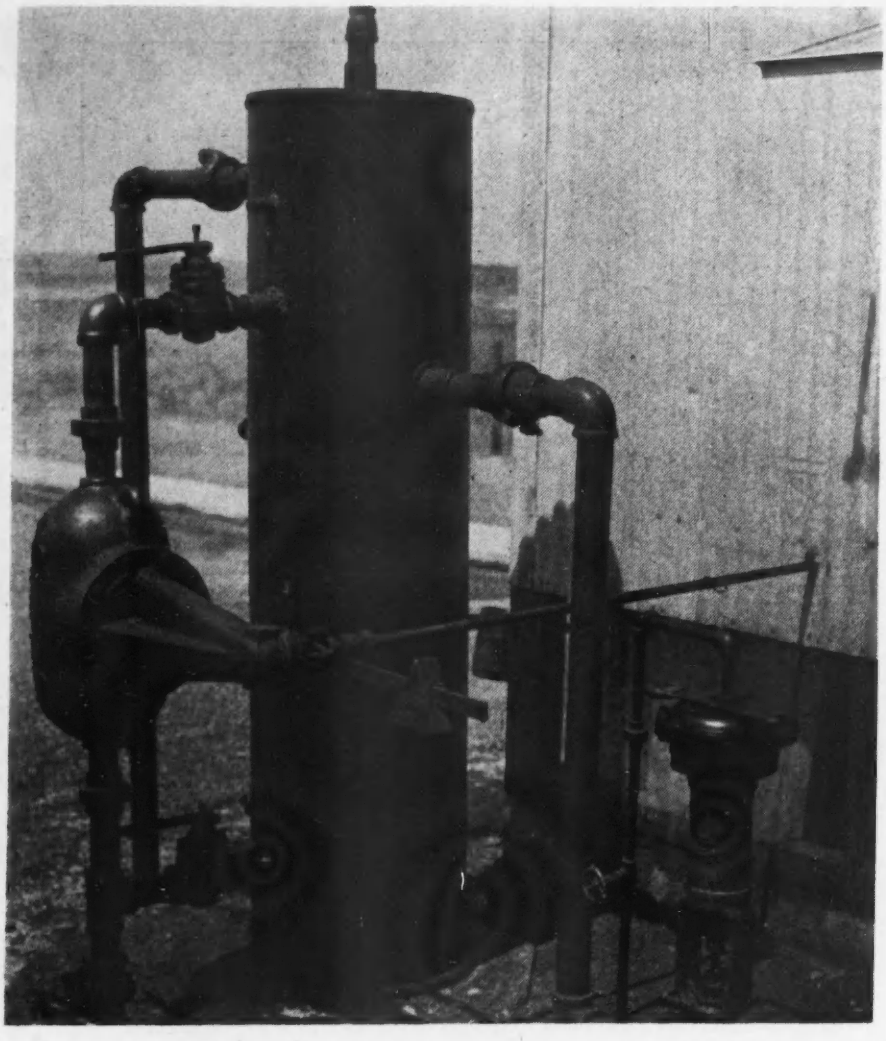


FIGURE 2. Pressure regulator and inlet connections to the gas scrubber where liquid is removed from the gas before it enters the compressor. The pressure-tight housing containing the fluid float ball is at the extreme left. Position of the float is transmitted through the horizontal shaft to the mercury switch which kills the engine when too much fluid accumulates in the scrubber.

fluids into a gun barrel where salt water is removed and the oil piped into stock tanks for pipe line delivery.

The gas which has been knocked out in the separator is held to a maximum of 32 and a minimum of 12 pounds per square inch. The latter pressure is necessary to force the fluids into the gun barrel and prevent the oil and water from entering the compressor system. The separator pressure is further reduced to 18 psi by a pressure regulator before the gas enters a scrubber to remove all the entrained liquids. Pressure in the line and in the scrubber between the two regulators (see diagram) is maintained within the limits of 12 and 22 psi. The minimum pressure is set as the value necessary to cause the fluids to flow from the separator into the gun barrel. The upper pressure limit has been established as the maximum allowable intake pressure which the compressor could handle safely. The engine is shut down if this pressure exceeds 22 psi to prevent exceeding the maximum intake pressure of the compressor in case the loaded-diaphragm back-pressure regulator fails to function. More than 18 psi would exist in the scrubber and intake line only if the two upstream regulators were to fail at the same time. Although this condition is not likely to occur, it is possible, and therefore the precaution is considered necessary.

The back-pressure regulator was designed into the intake line to maintain this 18 psi pressure on the scrubber, and permits only the gas in excess of this figure to pass through the regulator and into the compressor. In this manner, the compressor is prevented from removing the pressure in the line all the way back to the lease separator, in the event the wells fail to produce sufficient gas for a short period. Therefore, assuming that the two regulators function properly, it may be deduced that the intake pressure into the compressor will vary, and this is actually what happens.

At the time this study was made, the back pressure on the compressor intake was 16 psi. Gas entered the low-pressure cylinder, 10 x 10-inch double acting, where the pressure was boosted to 108 psi and the gas discharged into intercooler. The high-pressure cylinder, 4½ x 10-inch double acting, compressed the gas further to 440 psi and discharged it at this pressure into the gas-lift system. It was distributed at this pressure to each of four wells where the input pressure into the annulus varied from 380 to 420 psi.

Fuel Supply for Engine

Fuel for the natural gas, four-cylinder, 70-horsepower engine was supplied by the system from a tap just upstream of the back-pressure regulator on the compressor intake line shown in the diagram. A one-inch line was welded to the two-inch gas line and connected to a section of eight-inch casing which was buried in a horizontal position below ground level just outside the compressor station building. The cooling effect due to ground temperature condensed any remaining liquid in the gas. Liquids which accumulated in this section of casing were discharged into the burning pit by opening a valve in the discharge line. Pressure inside the casing forced the liquids into the pit, located about 200 feet from the compressor station.

Gas leaving the top side of the horizontal section of casing entered a spring-loaded diaphragm regulator where the pressure was reduced from 18 psi to six ounces, at which pressure the gas was piped to the engine.

Such a performance record probably would not have been possible had it not been for the protection afforded by both the mechanical and electrical devices which have prevented overloads on many occasions. These devices also were necessary since an attendant was not present at all times. In actual operation, the pumper tended the compressor station during the morning hours of each day, leaving it to operate in an automatic fashion for the remainder of the day and night. If, upon returning to the station in the morning during his rounds he finds the engine shut down, he needs only to check the pressures and temperatures which operate the control devices and he can soon locate the trouble.

Mechanical Safeguards

In addition to the various types of regulators already mentioned, other mechanical safeguards are in the form of pressure relief or pop valves placed at strategic points throughout the system. A pop valve on the gas scrubber opens in the event the pressure regulator upstream fails and well surges create high pressures in the vessel. Another pop valve is connected to the intercooler to perform a similar function. In case the intake pressure exceeds its permissible value and the gas is compressed in the low-pressure cylinder to a much higher pressure, the pop valve on the inter-

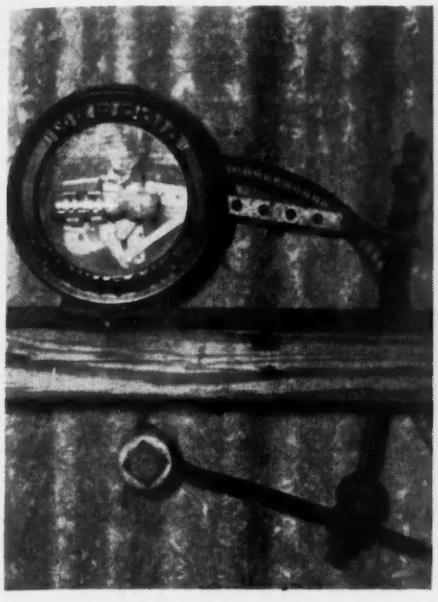


FIGURE 3 (left). Inside-station view of the mercury "tilt" switch which limits the fluid level in the gas scrubber. Electric connections go to ground and the engine magneto and normally are open. When tilted, due to excess fluid in the scrubber, the magneto is grounded, thereby stopping the engine and compressor.

FIGURE 4 (right). Back-pressure regulator on the compressor intake line. Sufficient pressure is maintained in the scrubber by this regulator to insure the flow of fluids from the lease separator into the gun barrel.

cooler will go off to release the high pressure.

During normal operations, the intercooler is under approximately 100 psi. If this valve fails to open and the compressor develops unsafe pressures, the pop valve on the discharge line will open to release the gas. In addition to the pop valve on the discharge line, a second vertical stand pipe also is employed to prevent overloading the gas distribution system. This section of 2½-inch pipe is sealed off from the atmosphere by a closed metal disc held firmly between two flanges. Excess pressure beyond the safe operating range will cause the metal disc to burst and the discharge pressure to be released to the atmosphere.

Electrical Sagefuards

These mechanical devices are in addition to electrical controls which are considered more precise in their supervision of the compressor station operation. Electrical switches throughout the station are set with their contact points open, and are connected in parallel. One side of the circuit is grounded while the other side is connected to the engine magneto through the instrument control switch.

So long as the contact points on the control switches are open, and they remain open as long as prescribed operating conditions exist, the magneto is not grounded, or shorted, and the engine continues to function. But, when any of the prescribed conditions exceed or drop below values considered safe, the switch contacts are closed and the magneto grounded to shut down the engine.

First electrical control found in the system, tracing the diagram, is the mercury tilt switch attached to the float on the gas scrubber. Function of this control element is to limit the accumulation of liquids in the scrubber so they will pass into the compressor with damaging results. The switch is actuated by a float operating inside a pressure-tight housing located outside the scrubber (Figure 2). A mechanical linkage, shown diagrammatically, transmits the float's position to the mercury tilt switch located inside the compressor station (Figure 3). If the fluid level rises beyond its predetermined safe level, the mercury switch will tilt, causing the mercury to make contact between two open points, stopping the engine. The pumper cannot start the engine under these circumstances until he manually empties the fluid from the gas scrubber to the burning pit. The gauge glass attached to the side of the vessel indicates the presence of fluid in the scrubber, and it is the practice of the pumper to empty this fluid each morning.

Second controller in the system is a pressure-actuated mercury switch operated by the pressure in the scrubber, which also is the pressure upstream of the back-pressure regulator. In the instance illustrated, this pressure is normally at 18 psi. If this pressure should drop to 12 psi, the double-contact mer-

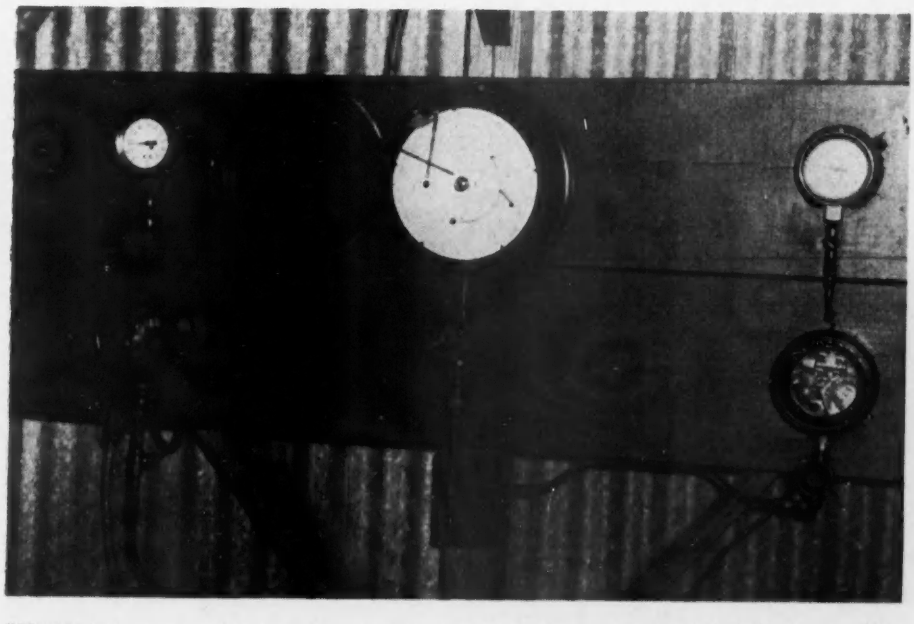


FIGURE 5. Instrument board in the compressor station. Gauge at upper left indicates scrubber pressure and is connected to the pressure-actuated mercury switch shown below. In the center of the board is the compressor discharge pressure recorder which maintains a continual record of the station performance. The mercury switch which limits the discharge pressure is in the lower right. Directly above this switch is the pressure-vacuum gauge which indicates the pressure or vacuum on the compressor intake line.

cury switch will ground the magneto and the engine will stop. It will remain grounded until the pressure is increased. This minimum pressure is required on the system up to this point in order that there be sufficient pressure in the separator to force the fluids into the gun barrel and thereby prevent water and oil from entering the compressor.

The pressure regulator upstream of the gas scrubber (see diagram) limits the pressure in the scrubber to a maximum of 18 psi. If the separator pressure drops to 18 psi or below, the regulator remains open, and the pressure in the gas scrubber under these conditions will equal the pressure in the separator. When the pressure drops to 12 psi, the switch is actuated and the compressor stops, and production from the four gas-lift wells will cease until the separator pressure is restored. In practice, this pressure is restored by flowing the head well as previously described.

The switch also has an upper limit which functions in the same manner to stop the compressor engine. The upper limit will ground the engine magneto when the pressure in the gas scrubber exceeds about 22 psi. This maximum limitation is an added precaution in case both regulators upstream of the compressor intake fail and the low-pressure cylinder is subjected to the separator pressure. Approximately 25 psi is considered the maximum safe intake pressure for the compressor; intake pressures above this value would overload the compressor.

Third in line of electrical watchdogs on the system is the pressure-actuated mercury switch attached to the compressor discharge line. This switch limits the discharge pressure to a maximum of 650 psi. If the discharge pressure exceeds this value, the switch closes to short out the engine magneto and the engine stops. This switch prevents overload presures on the gas distribution system. This pressure connection is also tied into a continuous chart recorder which makes a 24-hour record of the compressor discharge pressure. In the event that excessive discharge pressures cause a shutdown of the engine, a visual inspection of the meter chart will indicate that this condition was the source of the shut down.

Protection Provided Engine

Protection for the internal combustion engine is afforded by a combination electric controller. This device limits the engine temperature and the lubricating oil pressure. It is an electrical switch which also grounds the engine magneto in case the engine temperature exceeds about 200° F. or the lubricating oil pressure drops to a dangerously low point.

Of special interest is the method by which cooling is accomplished. The temperature controller is tapped into the engine head and actually limits the engine temperature. However, the cooling system which dissipates the heat generated by the engine also serves to cool the two compressor cylinders and the intercooler. An extra-large capacity radiator maintains operating temperatures in both the engine and compressor. The flow of water is through the radiator, into the cylinder walls of the compressor and through the intercooler, back to the centrifugal water pump, into the cylinder walls of the gas engine, and finally back into the radiator. If the temperature of the compressor and intercooler increases, it will be reflected in the temperature of the engine. When the engine temperature exceeds its safe operating point, the control switch automatically shuts the engine down. This would happen if the water supply in the cooling system became low due to leakage or evaporation. An additional cooling unit was eliminated by this design, as well as an additional temperature control for the compressor.

It is quite apparent from a close examination of the station design and the conditions under which the plant must operate that some careful engineering plus a thorough understanding of the production problem preceded the installation of the gas-lift system described. The variable conditions under which the compressor operates require 100 percent supervision, made possible only by the electric and mechanical devices limiting these conditions. Not only have these watchdogs minimized maintenance and repair expenses, but operating costs as well are kept at a minimum, since only a few hours' attention each day are required for satisfactory performance.

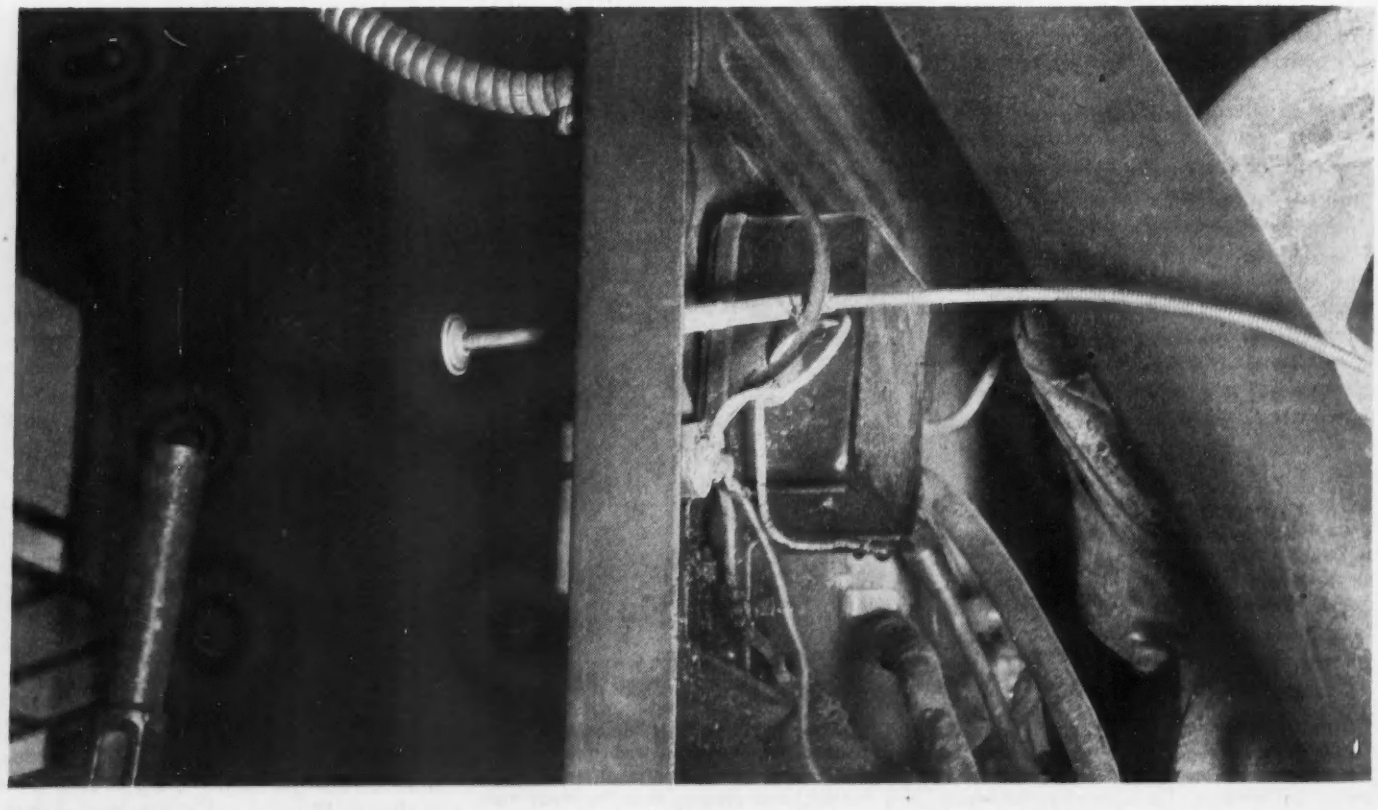


FIGURE 6. Combination pressure-temperature controller which limits the engine temperature and the lubricating oil pressure. If engine temperatures go too high or the oil pressure drops too low, this electrical device grounds the magneto and stops the engine.

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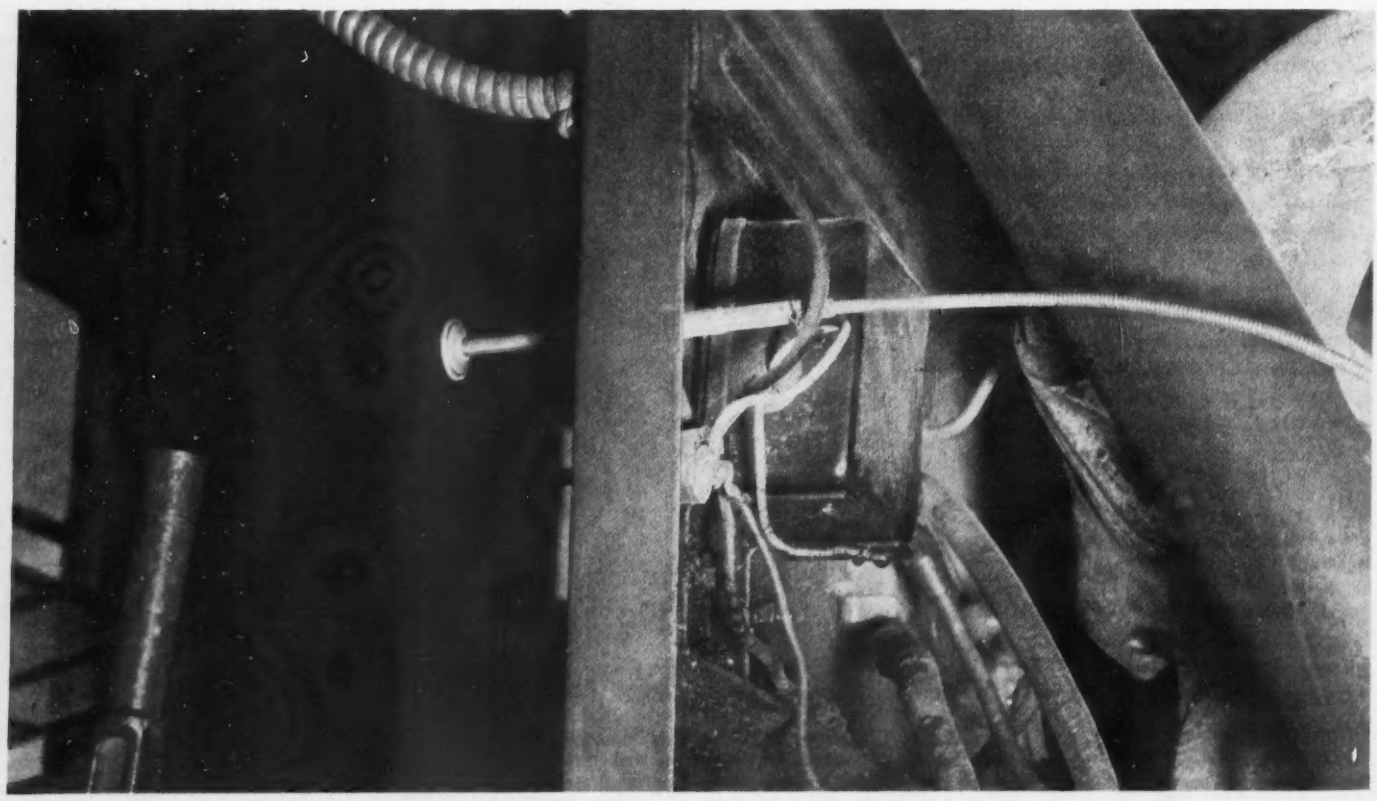

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Purification of Dehydrator Waste

Water drains from dehydrators into this metering box which tilts, when predetermined quantity is received, to present empty compartment for another filling. Water flows through pipe line to skimmer for next treatment.

Skimmer, with five compartments, which receives water with trace of oil for separation. Water is disposed of through field system and oil is accumulated in small concrete compartment from which it is pumped periodically to oil tanks for retreament.

By JOHN C. ALBRIGHT

WATER which is separated from oil in settling tanks and by the operation of electrical dehydrators is skimmed and prepared for ultimate disposal through a number of interesting steps accompanied by helpful equipment designed particularly for this unit. The water is measured as it flows from the dehydrator outlet by means of an automatic double-bucket metering device, designed so that when a predetermined quantity of water has been received in one-half of the apparatus, the weight automatically turns the unit on a trunnion, thus spilling the bucket of water into a receiving sump beneath, and presenting the other half of the unit beneath the spill openings for another measure of liquid. Each time the bucket turns, as it dumps first one way, and then back again during each cycle, the volume of water handled is registered on a counter which shows the current total quantity of water flowing from the dehydrators.

Skim Pond Construction

The skim pond is constructed as a double unit of concrete with a wall dividing the section, each section having both inlet and outlet compartments, as well as two oil skimming ponds. Water leaving the measuring device flows by gravity to the inlet compartment which is supplied with a horizontal distribution header, placed perfectly level, and containing a number of large perforations located exactly along the upper side, so that each perforation releases an amount of fluid equal to that of the other openings in the header. This is done so as to break the water and oil into a number of thin, shallow sheets to provide the maximum separation of waste oil from the water. Water sinks to the bottom of this narrow compartment from which it is transferred to the first section of the skim pond, rising through conductor pipes to a point just below the constant level of liquid in the pond. This is done to allow any droplets of oil accompanying the water to rise easily to the surface for separation. Free oil floats upon the surface until removed as required by the employe who attends to the operation of the oil cleaning plant.

Water flows progressively through the skim ponds, entering the first from the distribution header, where the bulk of the oil is collected. Water flows from this section to the second in a similar manner to rise beneath the surface so that practically all the oil leaving the dehydrators and drain canals is separated from the water. Each section of the pond is equipped with a manually operated skimming device so that the accumulation of oil can be removed periodically and as frequently as required without draining any appreciable quantity of water with the oil.

These devices are made by using bonnets from rising stem gate valves, mounted on a channel iron bracket attached to the walls of the skimming section. The bonnets are bolted to the support with the wedge stem extending down through a hole so that the lower end of the threaded stem can be attached to a "Y" shaped bail supporting a trough-like skimming ladle. This latter is made by splitting a short nipple of pipe and closing the ends, and having a hole in the center for welding a pipe nipple which slips snugly over the waste oil riser installed from the floor of the compartment to lead the oil to an accumulation pit from which the oil is pumped back to the treating plant.

Sometimes an unusually large quantity of water is separated from the oil, carrying an excessive amount of oil, as from a break in a line, or imperfect operation of some of the equipment in the treating plant and this slug flows into the skim pond. A release gate then is placed in one corner of the compartment last in operation permitting the operator to sluice the oil from the surface of the water without attempting to skim with the adjustable skimming apparatus.

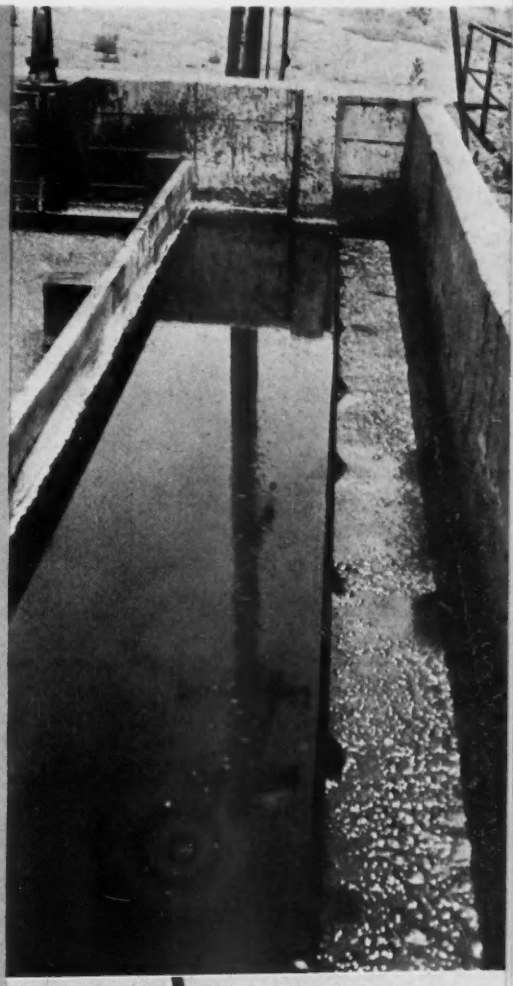
Receiver Trough

Clear water free of oil flows from the last compartment to a narrow receiver, similar to the first section where the perforated inlet pipe is placed, where a knife edged weir is set perfectly level so that the water flows evenly over the entire length and falls into a receiver trough leading to a line which carries the water to a tank from which it is pumped to the disposal system.

When winds blow trash from cultivated fields into the skimming sections, this refuse may be removed with little effort by using a basket net made by stretching a square of quarter-inch hardware cloth over a frame made from sucker rods. The gate valves placed by necessity below the surface of the ground are operated, opened and closed with an extension handle stored on brackets attached to the concrete walls of the skimming pond. At various points in and around the dehydration unit conventional fire control equipment is stored in substantial receivers made by using short nipples of line pipe having an inside diameter large enough that the 2½ gallon units will slip easily in and out, attached to three-inch pipe set securely into the ground. The units for combating fires are placed at a height permitting a man to grab an extinguisher "on the run."

TOP LEFT: Header in skimmer basin, laid level with transit, and which has numerous holes through which water and oil flow for accurate distribution to skimmer vats in next step.

TOP RIGHT: Water completely free of entrained oil flowing over accurately leveled weir into flume from which it passes to storage prior to pumping into disposal system in the field. Weir is made of metal with beveled face and set perfectly level so that water flows evenly over entire face.



LOWER LEFT: Manual controlled skimming device above oil drain line. Bucket is made by splitting pipe line nipple. Yoke attached to bucket and stem of rising stem gate valve to control level for accurate skimming. Larger nipple slides freely over drain pipe to prevent leaks.

LOWER RIGHT: Windstorms blow tumbleweeds into skimmer which are removed with this long handled basket net.

BELOW: Foamite fire extinguisher holders, made of line pipe nipples and welded to 3-inch pipe standard.

CORROSION CONTROL in Mid Continent Production

by C. C. MUNGER

THERE ARE few parts in the U. S. where corrosion in the production of petroleum is such a major factor as in the Mid-Continent area. There are some very local fields where difficult corrosion exists, such as in the Santa Maria field in California. It is doubtful, however, that these areas have the overall corrosion problems which exists in the Mid-Continent area extending from West Texas into Illinois and Wyoming.

THE crude in the Mid-Continent area combines the corrosive effects of both hydrogen sulfide and salt water. The main corrosive element in all of this area is hydrogen sulfide. This material is extremely active wherever metals forming sulfides are involved. Iron sulfide, of course, is the most common reaction product and when once formed, continues through a series of corrosive reactions which finally produce iron oxide or rust. The hydrogen sulfide corrosion of iron is particularly severe because of its chain of reactions. Once started, the hydrogen sulfide tends to regenerate itself in the corrosion process and continues reacting until all of the sulfide has been converted to iron oxide or dissipated in the air.

The extent of the hydrogen sulfide available in this area runs from entirely sweet crude around Houston to as high as 10,000 grains hydrogen sulfide per 100 cubic feet in Western Texas and to 15 percent hydrogen sulfide in the Elk Basin, Wyoming. As an example of this corrosion, the tubing in one well required replacement every 40 days, at which time the last 30 sections of the tubing were in such poor condition they hardly could be removed from the well.

The following are a few examples of hydrogen sulfide content which have been recorded in the West Texas area:

	Grains per 100 cu. ft.
Harper	800- 900
Keystone Lime	350
Keystone Ellenburger	40
McCamey	2000-10000
McElroy	4000
Penwell	2000
Sand Hills	2400
Waddell	2400
North Cowden	600
Goldsmith	3500
South Cowden	40- 7000

Another corrosive element common in these areas is salt water. This corrosion is closely coupled with hydrogen sulfide. In most cases it is a combination of sodium and magnesium chlorides and hydrogen sulfides which causes the most difficult problems. Salt water not only creates a problem in the production of petroleum but creates a disposal problem as well. Ordinary corrosion in salt water disposal tanks and piping is such that frequent replacement of piping or coating is required. Electrolysis and corrosion by earth current leakage are accelerated by the salt water.

Sulfate in Water

The sulfate content of the water is another factor in these fields which is of considerable importance. It creates a problem by the precipitation of a calcium sulfate or gypsum scale on production tubing, sucker rods, etc. The build-up of this scale not only reduces the area in the piping or tubing but many times has a tendency to aid in the corrosion. Corrosion here builds up as the dark oxide, causing bad pitting of the metal underneath the gyp scale. This type of corrosion occurs where limited amounts of oxygen are present. It is typical of corrosion aboard gasoline tankers where the blue oxide forms under heavy rust scale and causes a very

WATER ANALYSIS—SUBSURFACE FORMATIONS

	Formations	SO_4 ppm	Cl ppm
Oklahoma:			
Glenn Pool Area	Oswego Line	2	57178
	Glenn	44	77500
	Taneha	43	83000
	Arbuckle	134	115750
Burbank area	Bartlesville Sand	....	123000
	Suitcase	....	106600
Tonkawa area	Wilcox	394	139122
	Hoover	910	156114
	Tonkawa	246	153800
Seminole area	Calvin	156	92000
	Earlsboro	162	94500
	Cromwell	118	91300
	Hunton	760	96030
	First Wilcox	580	100880
Kansas:			
Russell area	Dakota	8500	34200
	Oswald	....	90679
	Arbuckle	2550	18720
Burton area	K. C. Lansing	Tr.	143000
	Miss. Line	35	100400
	Hunton Lime	960	37900
	Arbuckle	416	28100
Chase Silica area	K. C. Lansing	47	123200
	Arbuckle	2475	13980
Eldorado area	K. C. Lansing	....	123400
	Arbuckle	700	12950
Illinois:			
	Palestine	1800	50050
	Tar Springs	Nil	75190
	Cypress	1000	61000
	Benoist	....	62460
	Aux Vases	1908	75500
	McClosky	162	78800
	Devonian	4	42300
	St. Peter	1540	6875
New Mexico:			
	Santa Rosa	716	143
	Bowers Sand	682	185000
	Langlie Sand	7250	19830
	Penrose Sand	960	21000
	Reef Dolomite	985	2272
	Upper Grayburgls.	162	6710
	Lower Grayburgls.	108	4960
	San Andres	2040	4374

About the Author: C. C. Munger, director of research for the AMERCOAT Division of American Pipe and Construction Company, graduated from Pomona College, Pomona, Calif., in 1935 with a B.A. in Chemistry and went directly to American Pipe and Construction Company in the chemical laboratory to conduct research aimed at finding a coating for concrete to resist hydrogen sulfide in sewage gases. During the war special coatings were developed by Munger for use in the atom bomb plants at Hanford, Wash., and Oak Ridge, Tenn.

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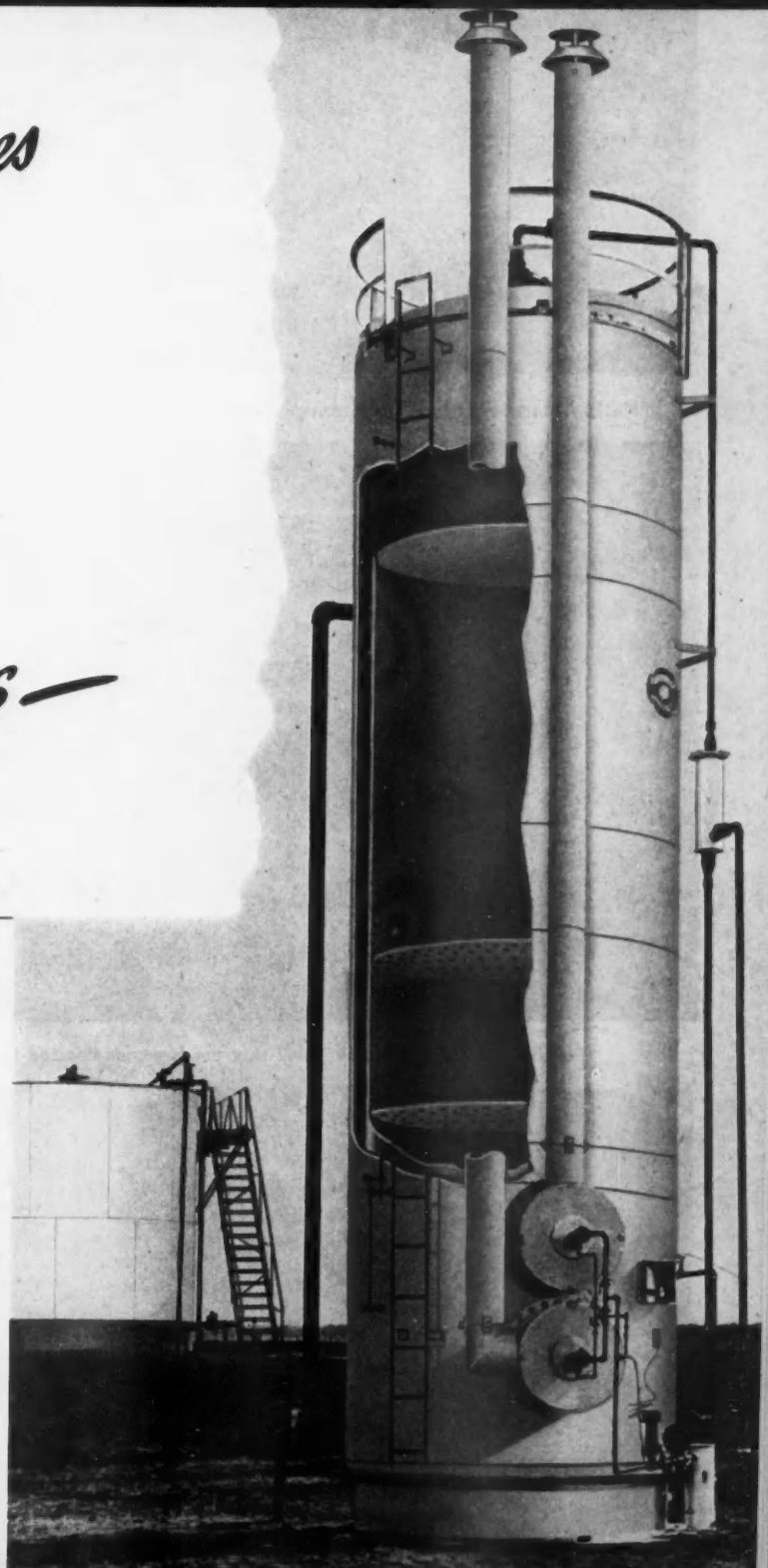

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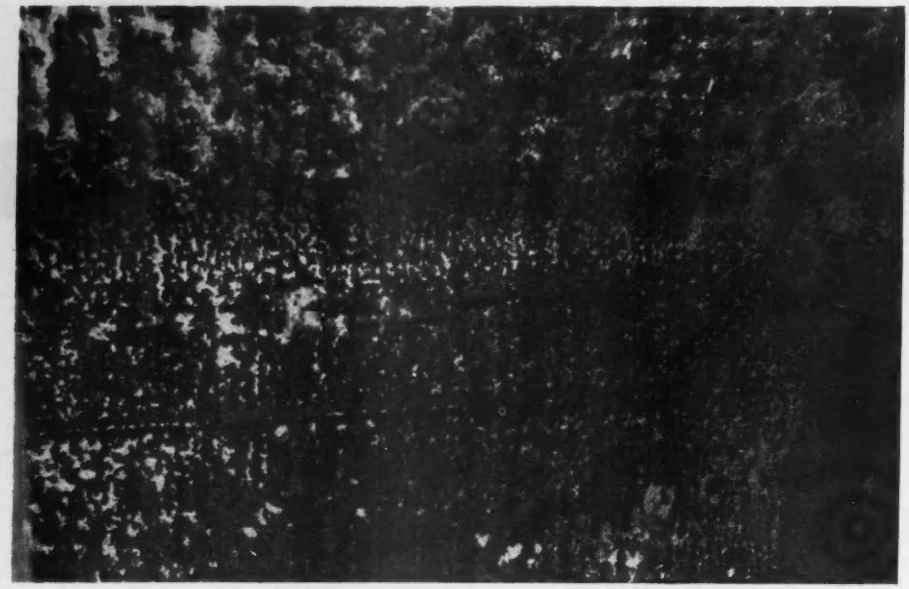

FIGURE 1. Interior surface of oil storage tank showing an extremely corrosive condition.

FIGURE 2. Crude oil storage tank that has been sandblasted for coating.

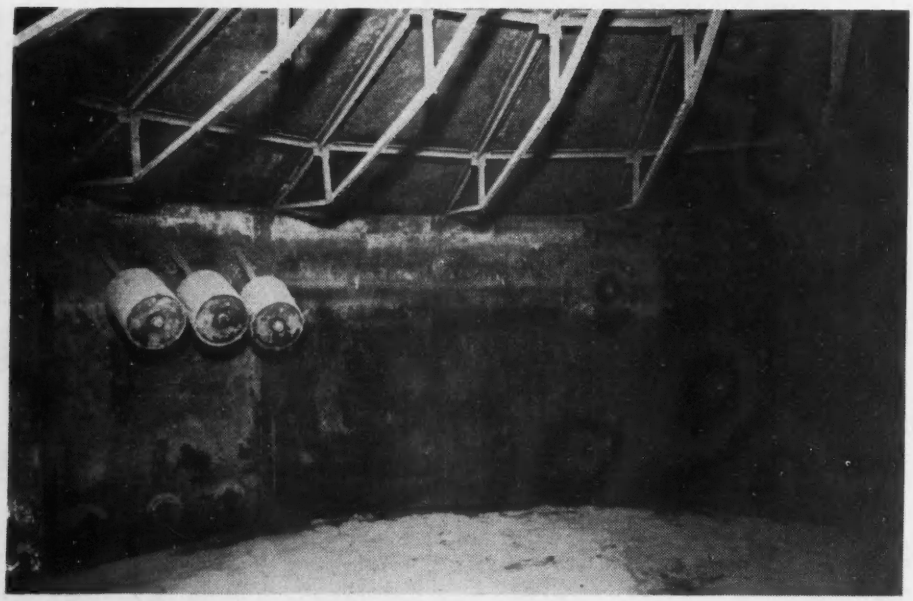

FIGURE 3. Crude oil storage tank interior showing corrosion and paraffin on side walls, and very severe corrosion on roof plates and supports.

tightly adherent but deep penetrating scale.

There is still another problem in the Mid-Continent area which may or may not aid in corrosion in the production of petroleum. In many cases there are no corrosion problems involved; however, a condition exists which can and does cause serious difficulty. This is the buildup of paraffin in the well tubing on the sucker rods and in the field piping and tanks. On one well it was necessary to clean the tubing and sucker rods every 14 days due to the rapid buildup of paraffin. The buildup of paraffin is caused by the gradual cooling of the oil as it is raised up the tubing from the oil level. The solubility of the paraffin in the oil decreases as the temperature decreases and it gradually precipitates out on the tubing, on the sucker rods and in the pipe and field tanks.

The main areas where the above types of corrosion exist are in West Texas in the Big Spring, Odessa and Midland areas where they have hydrogen sulfide, sodium chloride and paraffin as well. Following north, Western Kansas and Oklahoma have the same types of corrosion, hydrogen sulfide and sodium chloride; however, gypsum scale and paraffin are likewise encountered here. The Magnolia field in Arkansas is one of the worst in the country as far as hydrogen sulfide is concerned and vies with Elk Basin, Wyoming, for this dubious honor. Southern Illinois has to contend with salt water disposal and hydrogen sulfide, while eastern New Mexico has concentrations similar to West Texas.

Types of Corrosion

There are several types of corrosion which exist under the conditions which are found in these areas. The hydrogen sulfide probably is the material which can act in several ways to cause severe corrosion. Hydrogen sulfide corrosion is particularly difficult to control because it will regenerate itself during the process and thus the reaction will not run to completion until either the metal or the sulfide is eliminated.

The first type of sulfide corrosion which may exist is that of the reaction of hydrogen sulfide in the presence of moisture but with a limited oxygen supply which would possibly be the case in well tubing. The reaction is as follows:

$$Fe + H_2S = FE\ S + H_2$$
$$FE\ S + 2H_2O = Fe\ (OH)_2 + H_2S$$
$$H_2O + 2\ Fe(OH)_2 + \tfrac{1}{2}O_2 = 2Fe\ (O\ )_3$$
$$2Fe\ (OH)_3 = Fe_2O_3 + 3H_2O$$

In this case it can be seen that the hydrogen sulfide forms iron sulfide which in turn reacts with water to form ferrous hydroxide or a hydrated iron oxide. With the addition of water and some oxygen the ferrous hydroxide can

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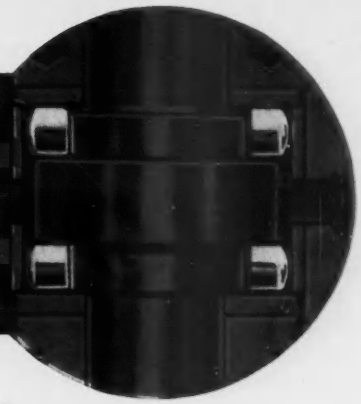

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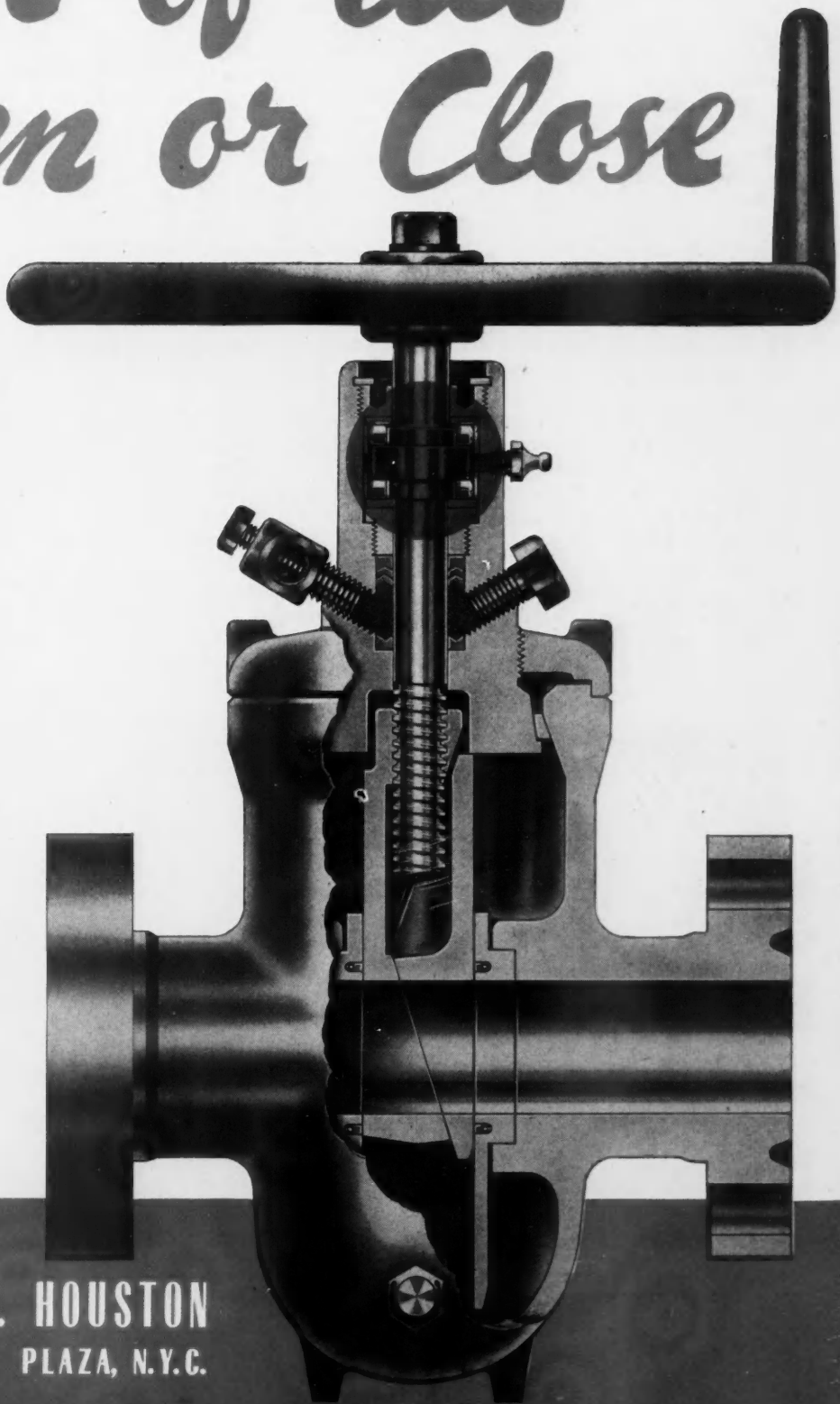

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further react to ferric hydroxide which can be dehydrated to the ordinary ferric oxide or rust. Most of the corrosion products formed, however, probably will be in the form of ferric hydroxide.

Another hydrogen sulfide reaction is as follows:

$$2H_2S + 3O_2 = 2SO_2 + 2H_2O$$
$$SO_2 + H_2O = H_2SO_3$$
$$Fe + H_2SO_3 = FeSO_3 + H_2$$
$$FeSO_3 + 2H_2O = Fe(OH)_2 + H_2SO_3$$

In the above reaction where there is an unlimited supply of oxygen and moisture, the hydrogen sulfide is oxidized to sulfurous acid which is turn reacts with iron to form ferrous sulfate before hydrolyzing to ferrous hydroxide and regenerating sulfurous acid. Then ferrous hydroxide can react with water and additional oxygen to form ferric hydroxide.

Another possible reaction where hydrogen sulfide is present is its action as a very dilute acid with some ionization. This, of course, can aid in the formation of local concentration cells and electrolysis, causing rapid pitting or corrosion of well tubing. In some cases it has been noted that the pH of water coming from a new well will be as low as 6.4; however, as corrosion increases in intensity there will be a neutralizing effect and the pH will increase to approximately 7.4. This phenomenon has been described as a neutralization of the ionized hydrogen sulfide by the increasing amount of ferrous hydroxide produced in the corrosion reaction. This tends to increase the pH.

Salt water corrosion is mainly that of the formation of local concentration cells by providing an excellent conductor of earth currents which may be picked up by the pipe and released by local discontinuity of the metal. The reaction of the local concentration cell is as shown in the accompanying diagram.

It can be seen that on a steel surface in contact with salt water a local area will tend to give off ferrous ions which will create a negative area on the surface from which electrons will move through the steel to the surrounding area where they will tend to neutralize the hydrogen ion in the sloution. As the hydrogen ions are neutralized, additional ferrous ions will go into solution, thus creating a corrosion pit at that point.

Another consideration in brine is where sodium chloride and magnesium chloride are involved. There is an hydrolysis of the brine which creates a dilute hydrochloric acid, thus lowering the pH of the solution and facilitating the corrosion reaction.

Where calcium sulfate or gypsum is a problem, scaling-up of the pipe may cause corrosion, especially where it is formed with salt brine; often a deposit of the calcium sulfate may tend to create local concentration cells which act in the same way as described above to cause pitting of the pipe underneath the gyp scale.

Corrosion in the production of petroleum starts with the well tubing and casing or sucker rods. The corrosion to this equipment, because of its inaccessibility and because of the high cost of removing and replacing it, can be one of the most costly and difficult areas of corrosion in the petroleum fields. The corrosion which exists here in the most severe areas is a combination of hydrogen sulfide and brine corrosion. Under these severe conditions well tubing and sucker rods have to be replaced at very short intervals, ranging from a few days to two or three months. Under sour production conditions the physical action of removing and replacing this equipment is extremely costly, even ignoring the cost of replacement materials and loss of production. Should a sucker rod break, several days of production time may be lost before replacement can be made.

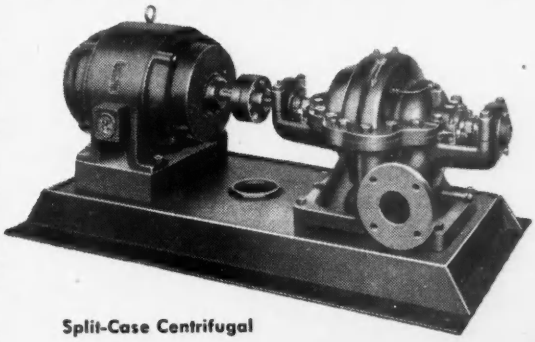
As the sour oil progresses from the well and enters the pipe lines to the production tanks, the pipe is subject to very similar conditions to the production tubing. However, as it enters the tank it encounters an increased supply of oxygen and the oxidized hydrogen sulfide creates a very severe corrosion condition. This occurs both on the underside of the tank decks where the oxidized hydrogen sulfide combines with the moisture of condensation, and in the tank bottoms where the hydrogen sulfide and the brine combine to form a highly corrosive mixture. Side walls of these tanks are subjected to some corrosion, although generally not as severe as in the top and bottoms. Salt water disposal tanks and lines are again subjected to the dissolved oxidized hydrogen sulfide and the brine, creating severe corrosive conditions while the sour oil goes into the pumping lines and eventually into pipe line pumping tanks. Here, the hydrogen sulfide again causes corrosion both in the bottoms and on the underside of the decks of these tanks.

So far we have dealt only with the mechanism of corrosion on the various equipment involved and not with any cure for the conditions which exist. A great deal of work has been done along this line. Two materials have been developed in recent years which may be compounded into coatings. These materials have excellent properties for resisting the above types of corrosion. The first is thermo-plastic vinyl resins. They may be compounded with proper solvents, pigments and modifying plasticizers to give coatings with a high resistance to hydrogen sulfide corrosion over a period of years. The second material is some of the more resistant pure phenolic synthetic resins which are thermosetting and when applied and cured properly, provide a dense, hard coating with good corrosion resistance.

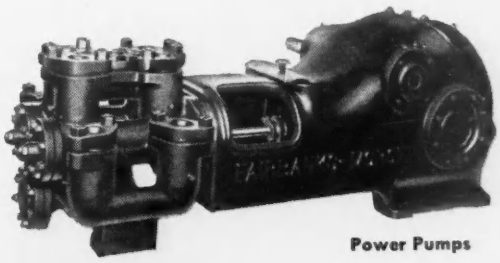
First use of the vinyl resins to combat the corrosive effects of hydrogen sulfide was in the sewage disposal field where coatings were developed and tested over a number of years in very high concentrations of hydrogen sulfide in sewage gas in the Southern California area. This work was conducted from 1935 on and it was with this background in hydrogen sulfide corrosion that the vinyl resins were introduced into the equally corrosive sour crude fields.

During a recent trip through western Kansas, considerable equipment of the above described types was inspected after having been coated for varying lengths of time with a coating made from the vinyl chloride type synthetic resins. In one instance, four coats of the vinyl chloride plastic coating were applied on well tubing and sucker rods in a well where normal replacement

FIGURE 4. Interior of crude oil tanker showing application of protective coating. Tanker corrosion problems in many respects parallel those encountered in the Mid-Continent area.



Split-Case Centrifugal



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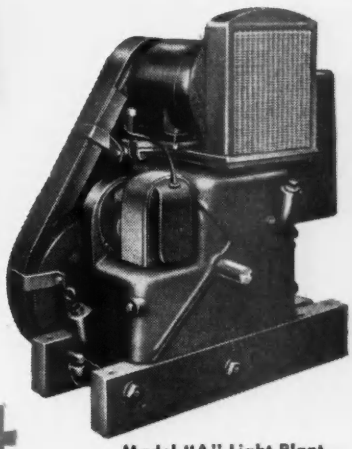
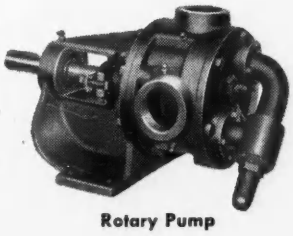
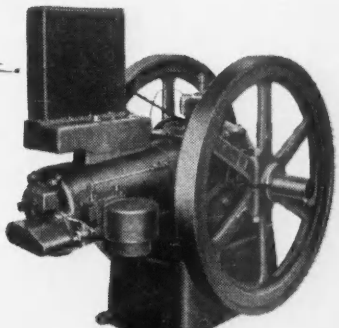


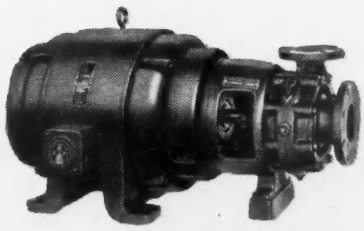
Model "A" Light Plant



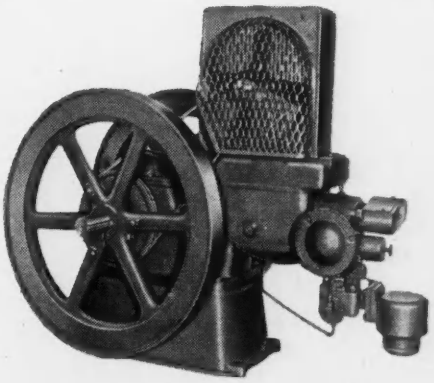
Rotary Pump



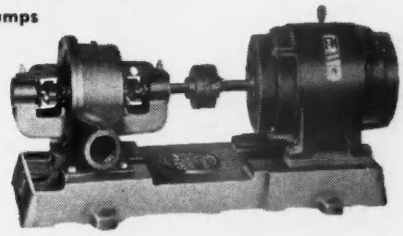
"ZC" Engine No. 739



Builtogether Pumps



"ZC" Engine No. 208



Westco Pumps

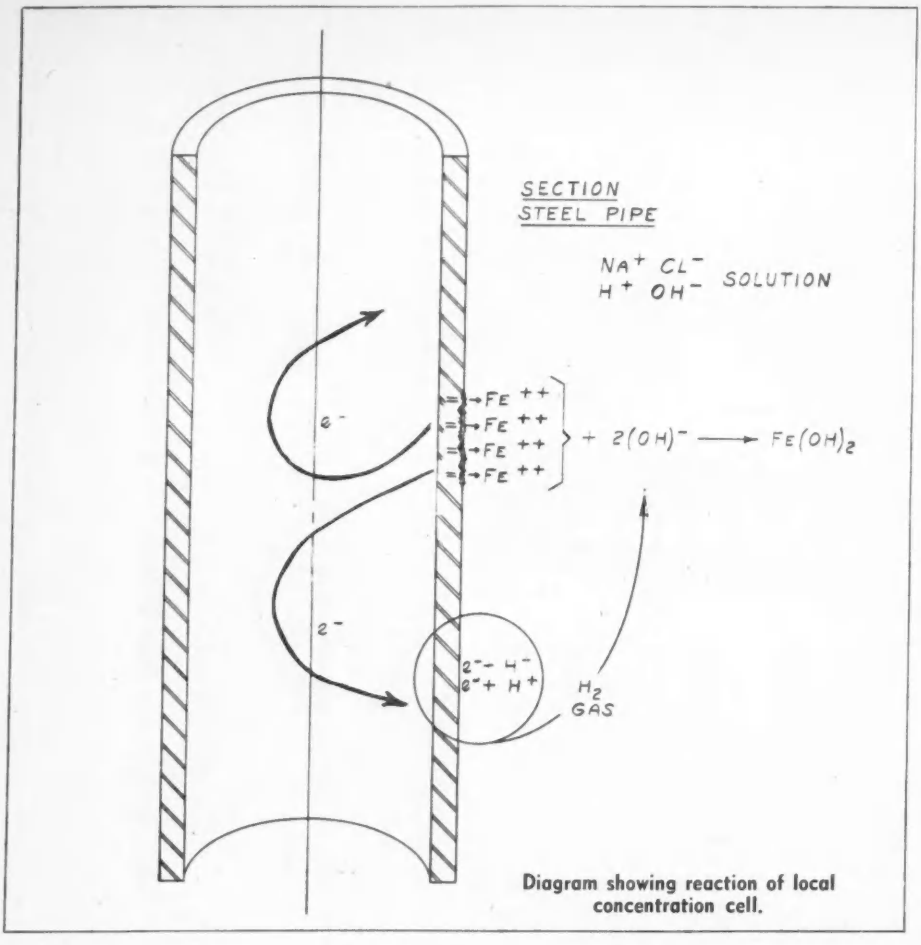


Diagram showing reaction of local concentration cell.

without a coating was every 60 days. Since coating, this equipment has been in service for more than a year without need of repair.

Three 100-barrel stock tanks of bolted construction in Rochelle, Kansas, were coated in August, 1946, with four coats of a thermoplastic vinyl coating. They were inspected last May and were in excellent condition. The bolt heads of the roof were uncorroded. This area would be the first to be attacked by corrosion since the bolt heads are the most difficult to coat completely. The hydrogen sulfide corrosion in these tanks is normally severe; however, the coating was unaffected.

Another low 500-barrel stock tank in Kansas was coated with the vinyl system. The coating was applied to the underside of a new steel deck in August, 1946, and on an inspection in May, 1947, no corrosion was evident. Previous to coating the new steel deck, the old deck had completely corroded away.

A low 500-barrel stock tank was coated with four coats of vinyl coating in July, 1946. This tank was inspected in May and appeared to be in excellent condition, including bolt heads, etc. The pumper on the lease confirmed the results of this inspection when the tank was completely cleaned down and free of all sludge.

Five low 500-barrel tanks were coated in October, 1945, with a vinyl coating system. When inspected in May, 1947, there was no corrosion in evidence.

Three tanks were coated in May, 1946, on the bottoms and tops only. When inspected during the trip all tanks were in excellent condition.

Three low 500-barrel tanks were being protected with four coats of the vinyl system. One tank was completed in April and put in service. Two of the tanks were incomplete and are mentioned only because of the extremely severe corrosion found. One tank was completely eaten away in the roof as well as on the bottom. The second tank required a complete new roof. This is an example of the corrosion existing in this service throughout the area. In the tank with the new roof was presented a graphic example of the regeneration of the sulfides on old steel. The roof of the tank was new and the whole tank was at the same time sandblasted down to bright metal. It was necessary to discontinue work on this tank for a few days and even in that short time corrosion started on the newly-blasted surface. It might be expected that the corrosion would be worse on the roof because of the condensation there, but this was not the case. The new steel, although showing a very slight amount of corrosion, was comparatively uncorroded. The side walls of the tank which previously had been badly corroded by hydrogen sulfide were completely red as though they had never been blasted. This is an excellent example of the regeneration of sulfides from minute particles and the penetration of the hydrogen sulfide into the steel. These are only a few examples of the many installations of this coating; however, they are representative.

Considerable work also has been done with the thermosetting baked phenolic type coating and some excellent results have been obtained for the same purposes. However, from the best knowledge available, these coatings have not been used as extensively nor for the variety of uses as have the more easily cold-applied vinyl chloride type coatings. Both have advantages and both can be used effectively to combat this corrosion. It is felt that with these two very different types of coatings, considerable progress has been made and will continue to be made in overcoming the various serious corrosion problems which exist in the Mid-Continent petroleum fields.

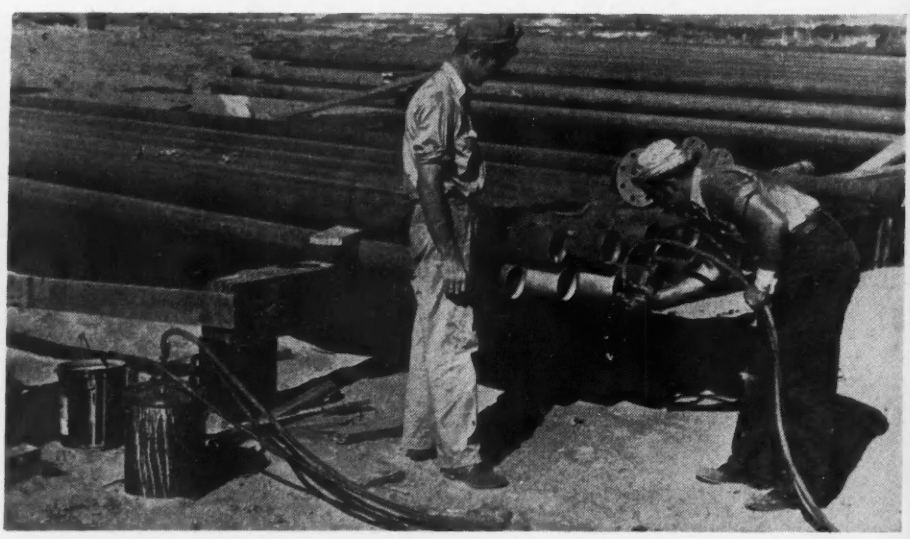


FIGURE 5. Unit for applying the coating material in the field or pipe yard. Dope pot is equipped with air hose for maintaining pressure, while blast carries spray of coating material throughout length of joint being protected.

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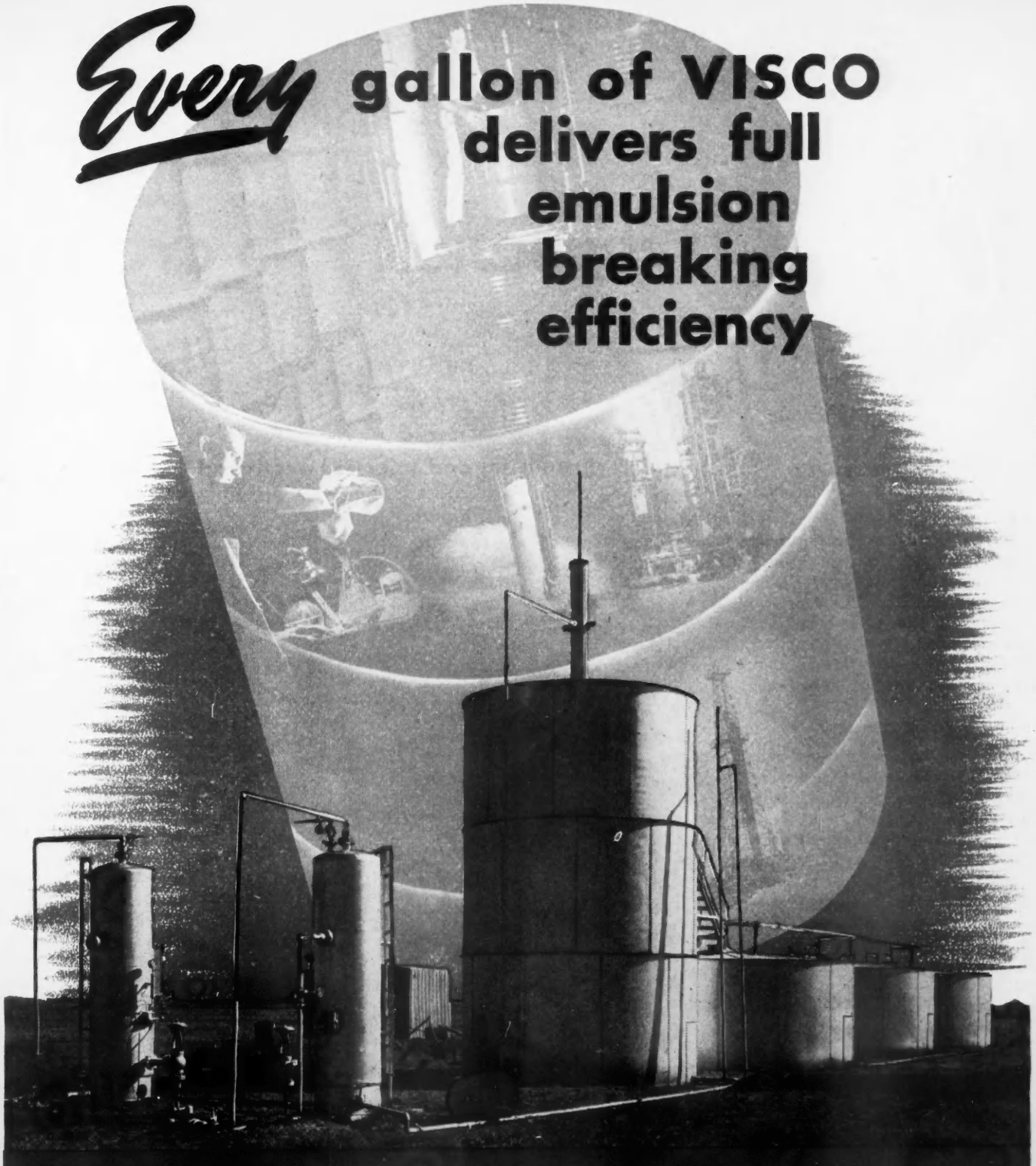

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Condensate PRODUCTION AND CYCLING

Part 11

Producing and Injection Wellhead Pressures

THE gas-producing rate through tubing should be fast enough to entrain condensate. A procedure for sizing tubing is indicated. Wellhead pressures for either producing or injection gas wells are expressed in terms of the static and resistance pressure factors and either the drawdown or buildup pressure.

Entrainment Rate

The gas-producing rate through tubing should be fast enough to entrain condensate. Otherwise, liquid accumulates on bottom. The liquid may be lost by gravitational or capillary migration. Furthermore, under some conditions, a liquid decreases the gas-producing capacity of a well. Tubing strings may be either uniform or tapered. The critical section is at the shoe of a uniform string. A tapered string may have several critical sections.

Field experience indicates that the producing rate Q, defined by the following equation, is likely to prevent the fall of liquids in tubing:

$$Q = 1.5D^{5/2}\left(\frac{P}{MTZ^2}\right)^{\frac{1}{2}} \qquad (1)$$

where

Q = million cubic feet per day
D = I.D. of tubing, inches
P = pressure, psia
M = molecular weight of gas, lbs.

Table 11-1
Data on I.D. of Tubing

Nominal SIZE	I.D	$D^{5.23}$	$\frac{15.1}{D^{5.23}}$
1¼	1.380	5.390	2.80
1½	1.610	12.07	1.25
2	1.995	37.04	0.407
2½	2.441	106.4	0.142
3	2.992	308.5	0.0489
3½	3.476	675.8	0.0223
4	3.958	1333	0.0113

T = absolute temperature, °R
Z = compressibility factor.

The curves in Figure 11-1 are solutions of equation (1). The data may be used to size tubing strings.

Wellhead Pressure

The wellhead pressure of condensate wells is given by

$$P_w^2 = P_b^2 e^{-S} - R(1 - e^{-S}) \qquad (2)$$

where S is the static factor

By PARK J. JONES,
Consultant

$$S = 37.5GL/TZ \qquad (3)$$

and R is the resistance factor in millions

$$R = \frac{15.1(QTZ)^2}{10^{12}\, D^{5.23}} \qquad (4)$$

When fully written out, equation (2) becomes

$$P_w^2 = P_b^2 e^{-37.5GL/TZ} - \frac{15.1(QTZ)^2}{D^{5.23}}\left(1 - e^{-37.5GL/TZ}\right) \qquad (5)$$

where

D = I.D. of pipe, inches
e = 2.718
G = gas gravity at standard conditions
L = length of flow string in thousand feet
P_b = bottom-hole presusre, psia
P_w = wellhead pressure, psia
Q = rate in million standard cubic feet per day
T = average temperature in flow string, °R
Z = compressibility factor at $(P_b + P_w)$ 2.

The values of $D^{5.23}$ and $15.1/D^{5.25}$ for 1¼ up to 4-inch nominal size tubing are itemized in Table 11-1.

Temperature in Producing Wells

The average temperature in a producing gas well is estimated with the aid of the following equation:

$$T_w = T_b\left[\frac{P_w}{P_b}\right]^{(0.4-0.267G)} \qquad (6)$$

where the subscripts b and w refer to bottom and wellhead absolute pressures and temperatures and G is the specific gravity of a gas. The curves in Figure 11-2 give the approximate ratio of the absolute temperatures in terms of absolute pressure ratio and gas gravity.

Example 1: The bottom-hole operating pressure in an 8000-foot well is 3500 psia when the rate of production is ten million per day. Gas gravity is 0.828; compressibility factor is 0.86; and the average flowing temperature is 180° F. Size a uniform tubing string and estimate the wellhead pressure. In this example, M = 29 (0.828) or 24. So

$$\left[\frac{P}{MTZ^2}\right]^{\frac{1}{2}} = \left[\frac{3500}{24(640)(0.74)}\right]^{\frac{1}{2}} = 0.56$$

Table 11-2
Basic Data for an Average Well
Initial Reservoir Conditions

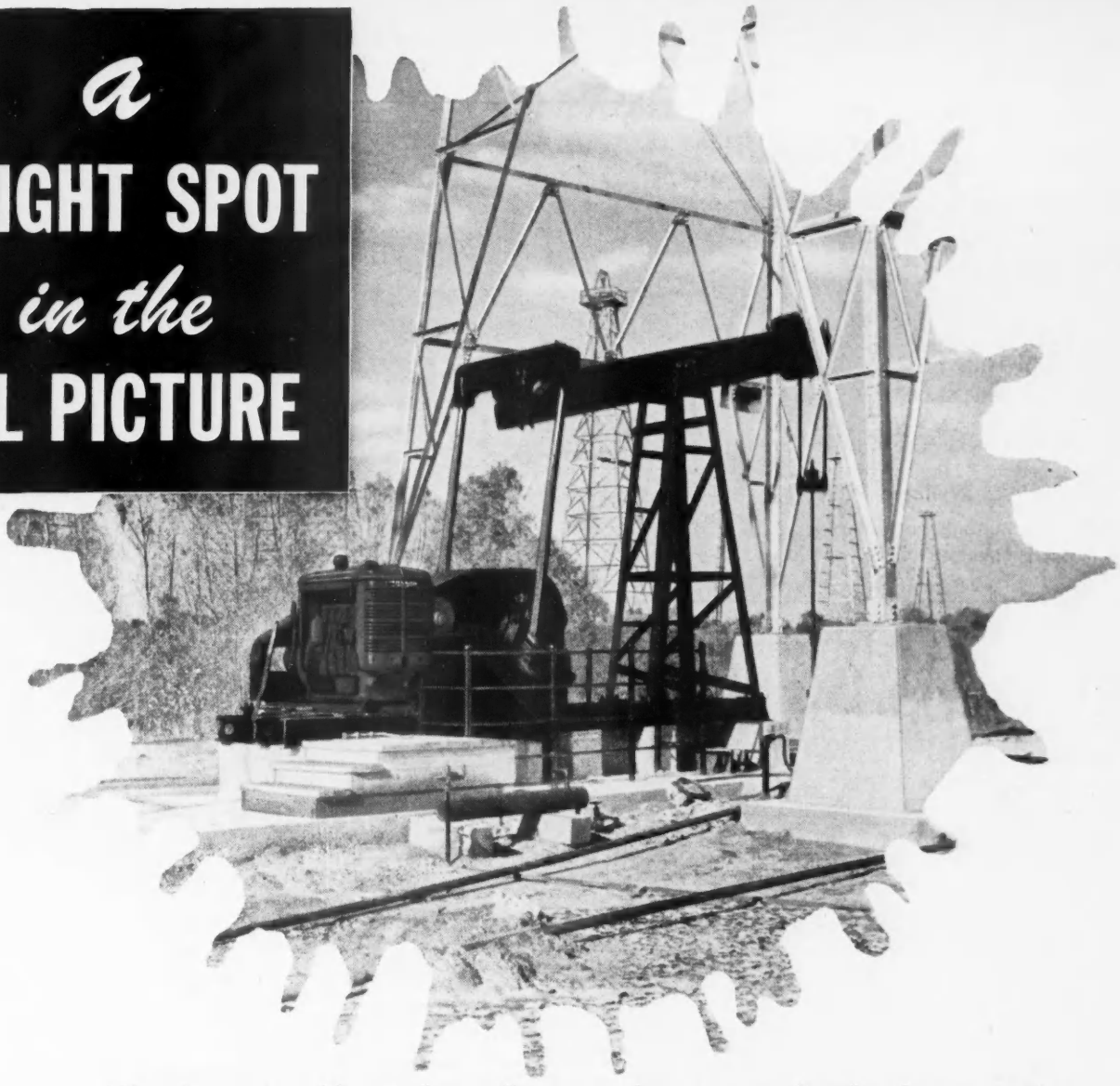
L = 8000′	N = 6
h = 30′	I—0.7
K = 400 mds	r = 8″
T = 660 °R	d = 6000′
P_{ro} = 3600 psia	log d/r = 4.26
G = 0.828	μ = 0.026 cps
M = 24	Z = 0.85

$P_r^2 - P_b^2 = F = 0.0245Q$

Initial Condition in Tubing

Nominal size = 2½	$15.1/D^{5.23} = 0.142$
T = 640 °R	Z = 0.82
G = 0.828	S = 0.485
$e^S = 1.624$	$R = 0.0391Q^2$

a BRIGHT SPOT *in the* OIL PICTURE



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and by Figure 11-1, three-inch tubing should be used.

By equation (3)

$$S = 0.0375(0.828)(8000)/(640)(0.86) = 0.451$$

so $e^{-S} = 0.637$ and $(1 - e^{-S}) = 0.363$.

From Table 11-1, $15.1/D^{5.22}$ equals 0.0489 and by equation (4)

$$R = 0.0489\,[10(0.640)(0.86)]^2 = 1.48 \text{ million}$$

The wellhead pressure is defined by equation (2). Thus

$$P_w = 1000\,[12.25\,(0.637) - 1.48\,(0.363)]^{\frac{1}{2}} = 2700 \text{ psia}$$

Reservoir to Wellhead Pressure

Upon eliminating bottom-hole pressure between equation (6) of part 10 and equation (5) in this article, we have

$$P_w^2 = \left(P_r^2 - \frac{\mu QTZ \log \frac{d}{r}}{305NIhK}\right) e^{-37.5GL/TZ} - \frac{15.1(QTZ)^2}{D^{5.22}}\,(1 - e^{-37.5GL/TZ})$$

Let

$$F = \frac{\mu QTZ \log \frac{d}{r}}{305NIhK} \qquad (7)$$

then

$$P_r^2 - P_w^2 e^S = F + R\,(e^S - 1) \qquad (8)$$

Equation (8) combines the drawdown in a rservoir, which is called F the pressure loss in a formation, with the resistance and static pressure factors R and S. The value of TZ in F is relative to reservoir conditions. Whereas, the value of TZ in R and S is relative to the average pressure and temperature in tubing. The value of F is in terms of an average well for a group of N wells.

The curves in Figure 11-3 illustrate a solution of equation (8) for a particular gas well. A 3160 psia reservoir pressure is denoted by the P_r line. The operating bottom-hole pressure is P_b. The difference $(P_r - P_b)$ is the drawdown in a reservoir. Assume flow through tubing is frictionless, then the difference $(P_b - P_w)$ for the frictionless line gives the static component of the pressure loss between tubing shoe and wellhead. The difference between the frictionless wellhead pressure and the wellhead pressure for a given producing rate through a given tubing gives the resistance component of the pressure loss in tubing. The difference $(P_b - P_w)$ is the pressure loss in tubing. The difference $(P_r - P_w)$ is the total pressure loss from reservoir to wellhead.

Data of the type shown in Figure 11-3 are relative to a fixed reservoir pressure. In order to show the influence of declining reservoir pressure on wellhead

Table 11-3
Producing Characteristics at 3600 Psia

Million/day/well	2	4	6	8	10
F=0.0245Q, million	0.049	0.098	0.147	0.196	0.245
P_b^2, million	12.911	12.862	12.813	12.764	12.715
Bottom-hole pressure, psia	3593	3586	3580	3572	3565
Drawdown, psi	7	14	20	28	35
$R=0.0391Q^2$, million	0.156	0.626	1.408	2.502	3.910
$R(e^S-1)$, million	0.097	0.391	0.878	1.561	2.440
$E=F+R(e^S-1)$	0.146	0.489	1.025	1.757	2.685
$P_w^2=12.96-E$	12.814	12.471	11.935	11.203	10.275
P_w^2, million	7.890	7.679	7.349	6.898	6.327
Wellhead pressure, psia	2810	2770	2710	2620	2510
ΔP in tubing, psi	783	816	870	952	1055

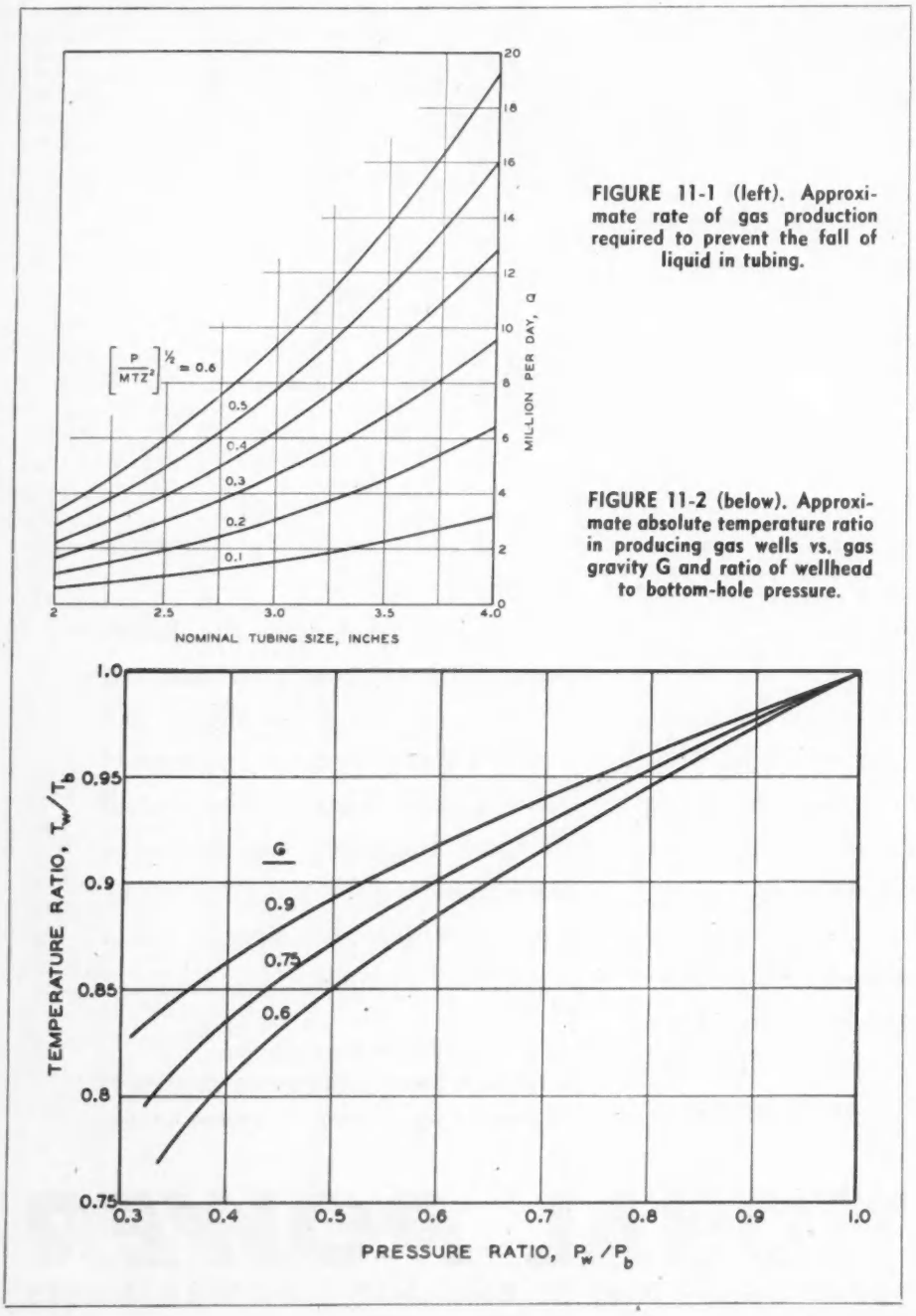


FIGURE 11-1 (left). Approximate rate of gas production required to prevent the fall of liquid in tubing.

FIGURE 11-2 (below). Approximate absolute temperature ratio in producing gas wells vs. gas gravity G and ratio of wellhead to bottom-hole pressure.

Table 11-4
Conditions at 1800 Psia Reservoir Pressure

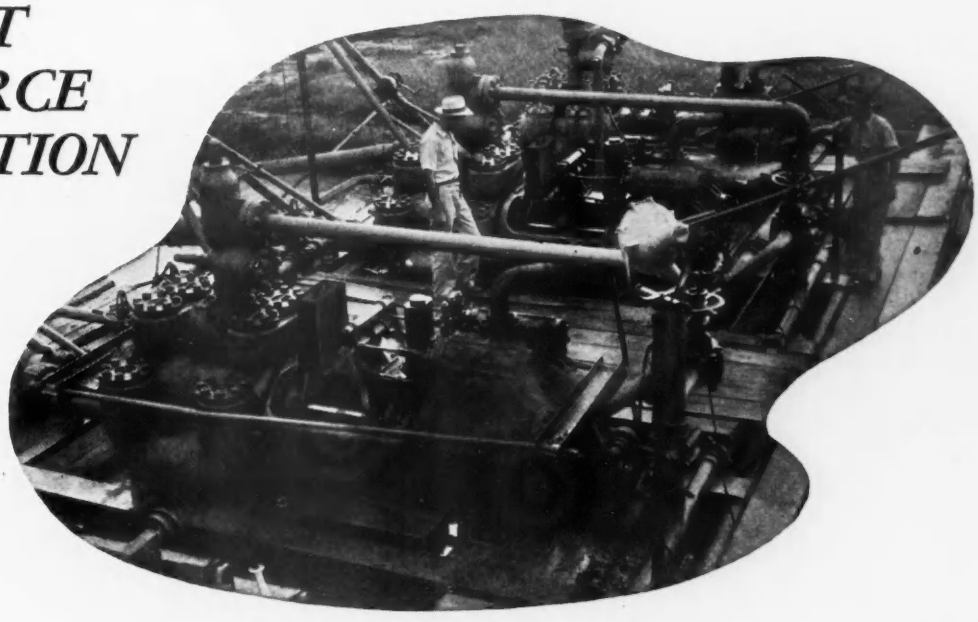
Conditions in Reservoir

$P_r = 1800$ psia $\quad G = 0.724$
$Z = 0.88 \quad \mu = 0.018$
$P_r^2 - P_b^2 = F = 0.0176Q$

Conditions in Tubing

Minimum $P_w = 800$ psia $\quad T = 610\ ^\circ R$
$G = 0.724 \quad Z = 0.90$
$S = 0.396 \quad e^S = 1.485$
For 2½" tubing, $R = 0.428Q^2$

AT PIERCE JUNCTION



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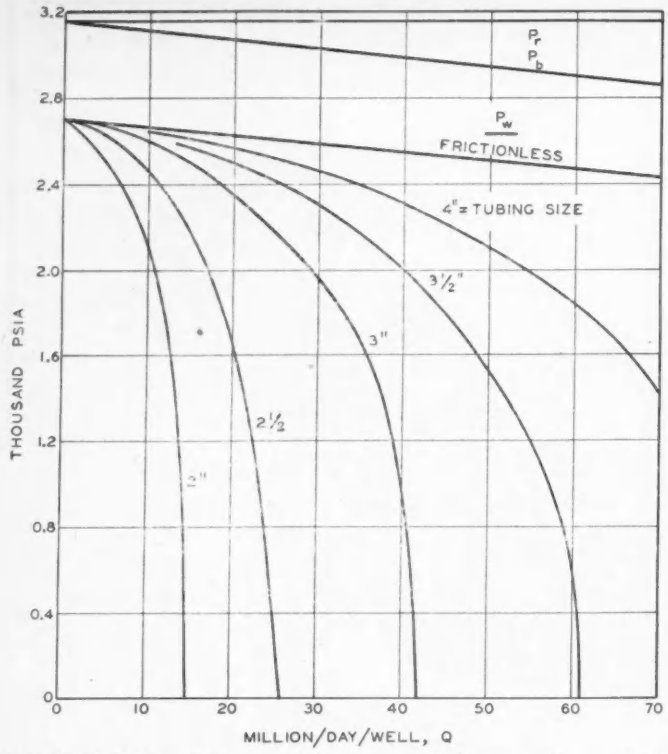

FIGURE 11-3 (above). Pressure data for a particular gas well vs. rate Q and nominal tubing size; P_r is reservoir pressure; P_b is bottom-hole; and P_w is wellhead.

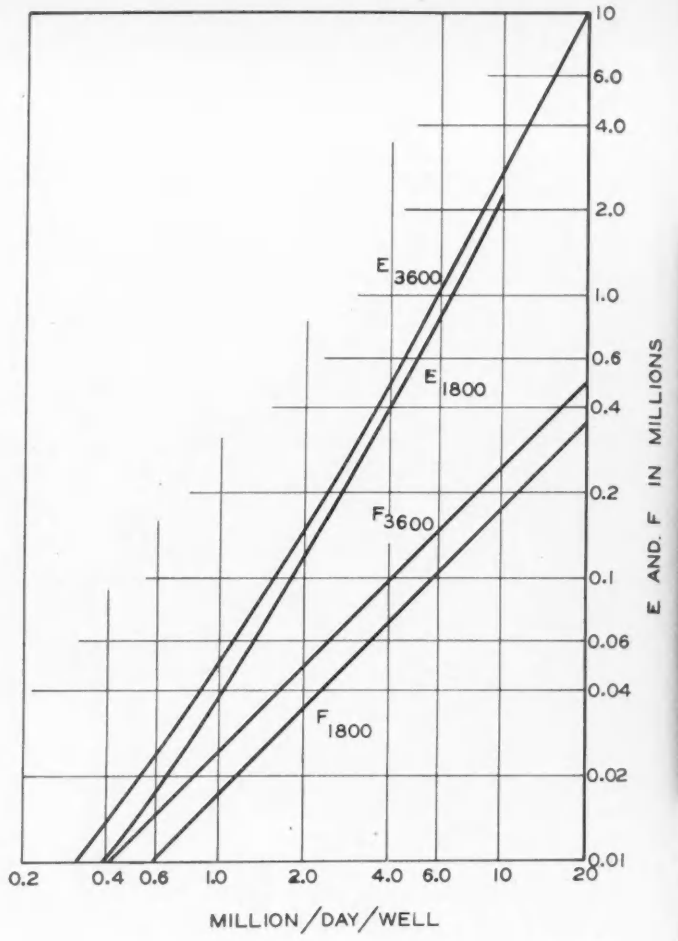

FIGURE 11-4 (right). Producing characteristics of a rich gas well through 2½-inch nominal-size tubing at 3600 and 1800 psia reservoir pressure; F is pressure factor for reservoir; E is pressure factor for well.

pressure and producing rate, equation (8) is plotted on log-log paper.

Producing Characteristics

The producing characteristics of an individual well, or of the average well for a group of N wells, are mapped out on log-log paper. Figure 11-4 is an illustrative example for the conditions itemized in Tables 11-2 through 5. The data are for six 8000-foot wells averaging 30 feet of completion in a 400 millidarcy sand. Production is from all sides. The distance to productive limits averages 6000 feet. The interference between wells is about 70 percent. The initial reservoir pressure is 3600 psia. The initial shutin wellhead pressure is 2825 psia. The wells have 2½-inch nominal size tubing.

The F lines in Figure 11-4 show the formation pressure factor at 3600 and 1800 psia reservoir pressure respectively. The E curves show the producing characteristics at the time reservoir pressure is either 3600 or 1800 psia.

Suppose the minimum operating wellhead pressure is 800 psia. The initial per-well average capacity against the 800 psia is the rate Q for which

$$E = 12.96 - 0.64(1.624) = 11.92$$

The E_{2500} curve indicates that Q is about 22 million per day.

Suppose the plant throughput is 60 million per day. The six wells will average 10 million/day/well until the reservoir pressure declines to a value for which

$$P_r^2 = 0.64(1.485) + 0.176 + 4.28(0.485) = 3.20$$

or approximately 1800 psia. The corresponding value on the E curve for 1800 psia is the end point 2.25.

Gas Injection Characteristics

For gas injection wells,

$$P_w^2 = P_b^2 e^S + R(1 - e^{-S}) \qquad (9)$$

The bottom-hole operating pressure is given by

$$P_b^2 = P_r^2 + F \qquad (10)$$

Upon eliminating bottom-hole pressure, we have

$$P_w^2 e^S - P_r^2 = F + R(e^S - 1 \qquad (11)$$

The work required to inject gas is done on the surface and the left side of equation (11) is negative by comparison with producing wells for which work is done in reservoirs. The formation pressure factor F here represents buildup rather than drawdown. Equation (7) defines the value of F when log d/r is replaced by log 2d/r, that is, the advancement of injected gas is usually in one general direction. The distance d is approximately half the distance between injection and producing wells. Applications of equation (11) will be illustrated in later articles.

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[1] Moody, L. F., Friction Factors for Pipe Flow, Trans. ASME 66, 671 (1944)

[2] Buthod and Whiteley, Fluid Flow, The Oil and Gas Journal, Dec. 27, 1945.

Table 11-5
Producing Characteristics at 1800 Psia

Million/day/well	2	4	6	8	10
F = 0.0176Q, million	0.0352	0.0704	0.1056	0.1408	0.1760
P_b^2, million	3.205	3.170	3.134	3.099	3.064
P_b, psia	1790	1780	1770	1760	1750
Drawdown, psi	10	20	30	40	50
2½ Inch Tubing					
$R = 0.0428Q^2$, million	0.171	0.685	1.541	2.739	4.280
$R - e^S - 1)$, million	0.083	0.332	0.747	1.328	2.076
E, million	0.118	0.402	0.852	1.469	2.252
$P_w^2 e^S = 3.24 - E$	3.122	2.838	2.388	1.771	0.988
P_w^2, million	2.012	1.911	1.608	1.193	0.665
Wellhead pressure, psia	1450	1380	1270	1090	815

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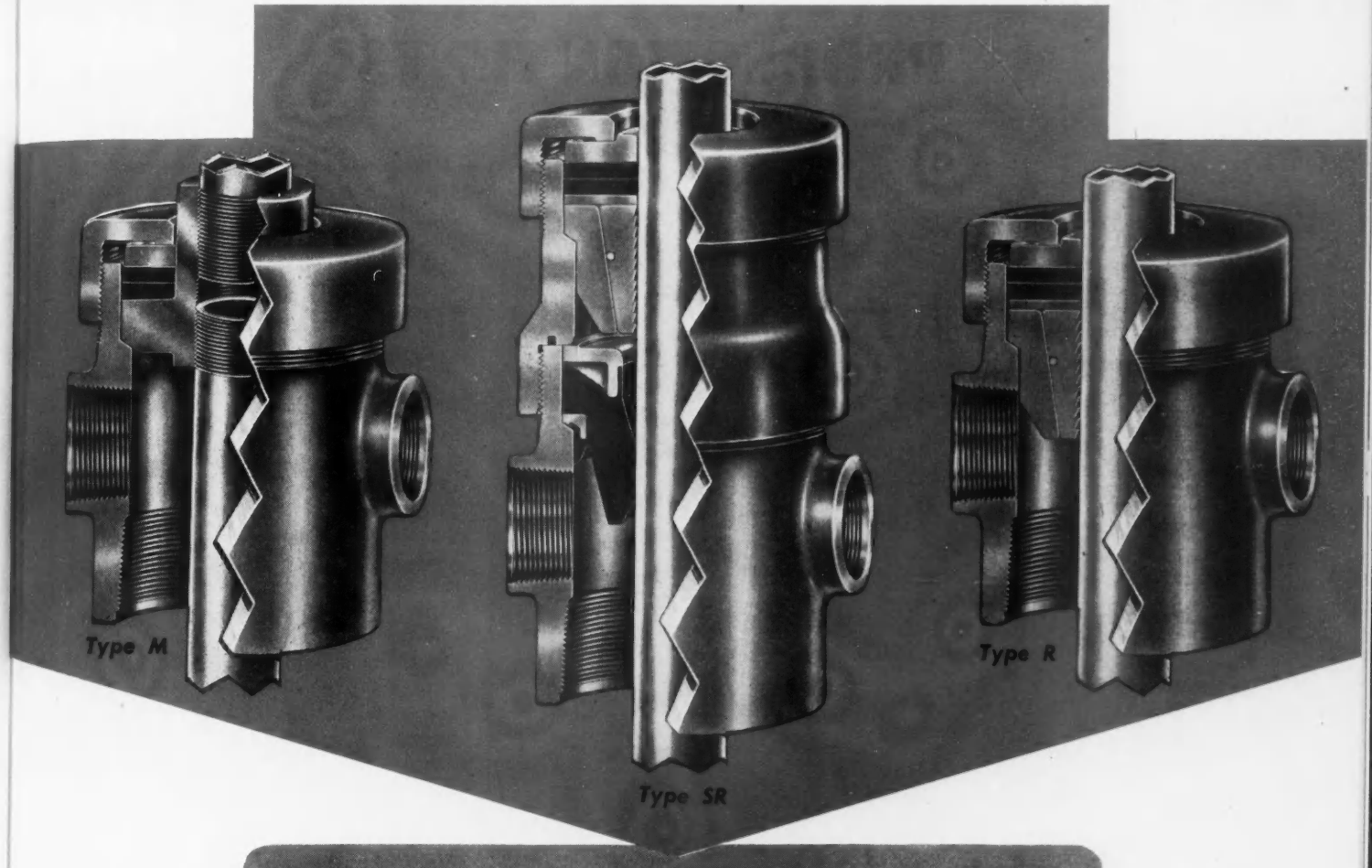

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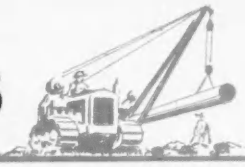

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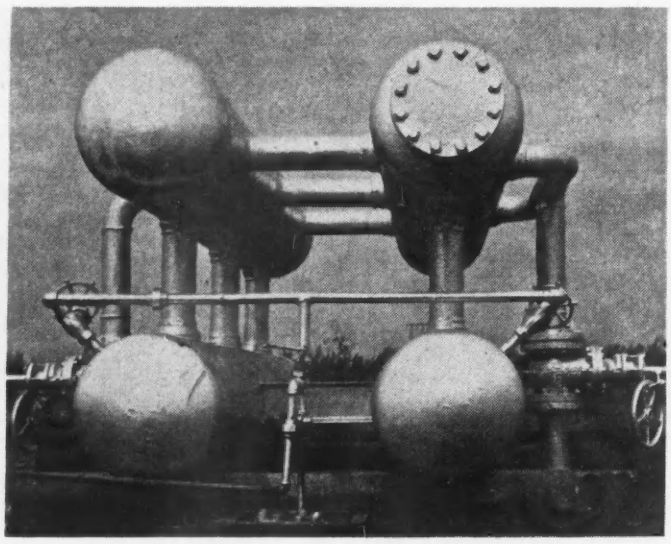
How To—Fabricate Moisture Knock-Out Unit on Natural Gas Flow Line

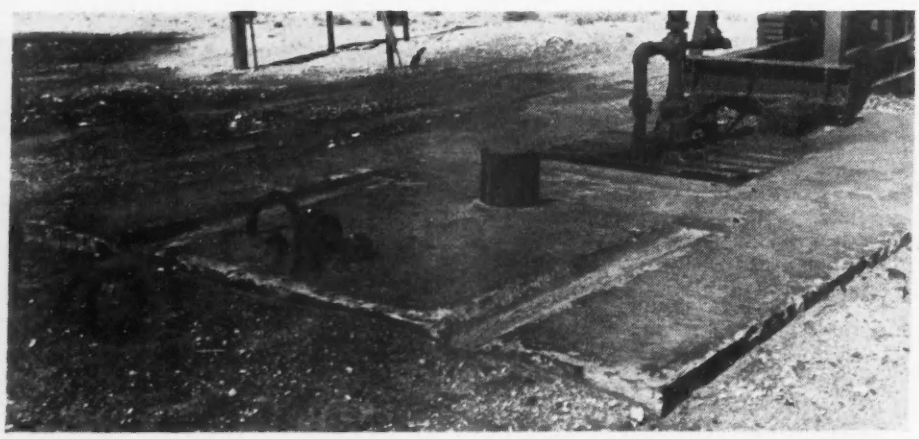


One producing company has designed a compact knock-out for removing entrained water from natural gas. The unit consists of four cylinders, formed from 14-inch pipe with dished ends welded on all ends with the exception of one. The upper right cylinder shown has a bolted head to permit inspection for possible internal corrosion.

Each upper cylinder is connected to the one immediately below it with three four-inch risers, a similar set of three four-inch pipes connecting the two upper cylinders on their mid-diameters. Flow is into the left upper cylinder through the four-inch pipe at the extreme left. Then the gas passes through the cylinder, divides to flow through the three horizontal four-inch lines to the second upper cylinder, where it is again deflected and finally flows through the two branches into the line at the right.

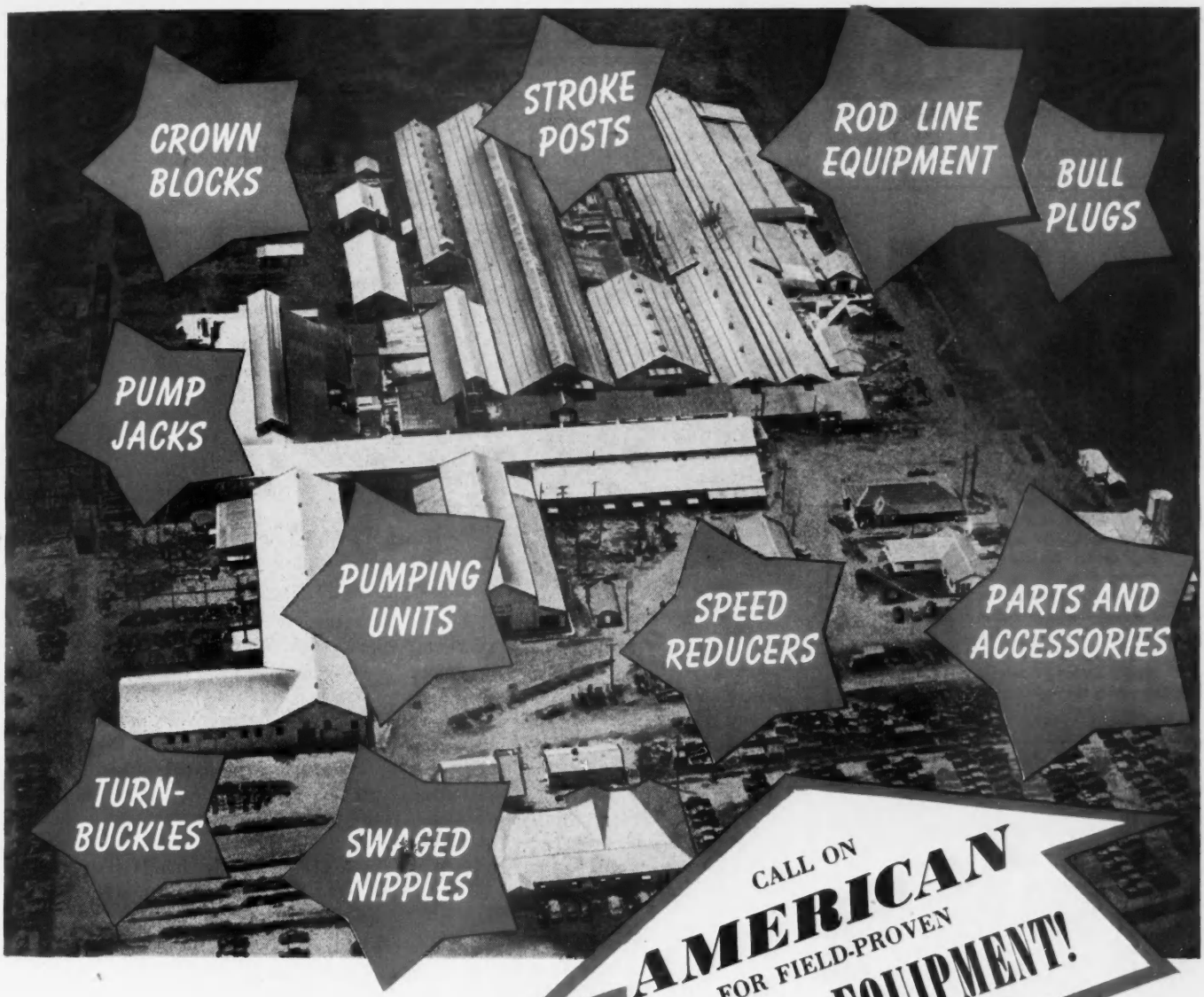
Any water which drops out of the stream in either upper cylinders flows into the lower cylinder where it accumulates until it reaches the level of the tie-in of the ¾-inch drain line in the foreground. Fluid pressure forces the water into the drain line, thence through the drop leg midway between the pairs of cylinders to an inverted bucket type trap almost hidden in the small pit. This trap discharges water into a drain through a line which parallels and is hidden by the manually controlled drain line leading to the left in the view.

How To—Speed Placement of Pulling Units at Well Site



Reduction of the rigging-up time of single mast pulling units may be accomplished through preparation of the concrete mat surrounding the well head. One company operating in the West Texas area found it desirable to leave shallow grooves in the slab to facilitate guiding the vehicle and assuring its proper placement in backing up to the well. When the rear wheels follow the grooves, the driver knows the unit is "square" with the well, with only the distance from the well head being determined by signals from a man at the well.

Another measure designed to aid in the rapid positioning of the mast consists of a short half-section of casing which is embedded in the concrete at the proper point between unit and well head. Illustrated, this guide assures perfect alignment of the mast and further assures that skidding or shifting of the footing is not possible when hoisting a heavy string of tubing or rods. Tie-down eyes of conventional design are bolted to the concrete in the usual manner.



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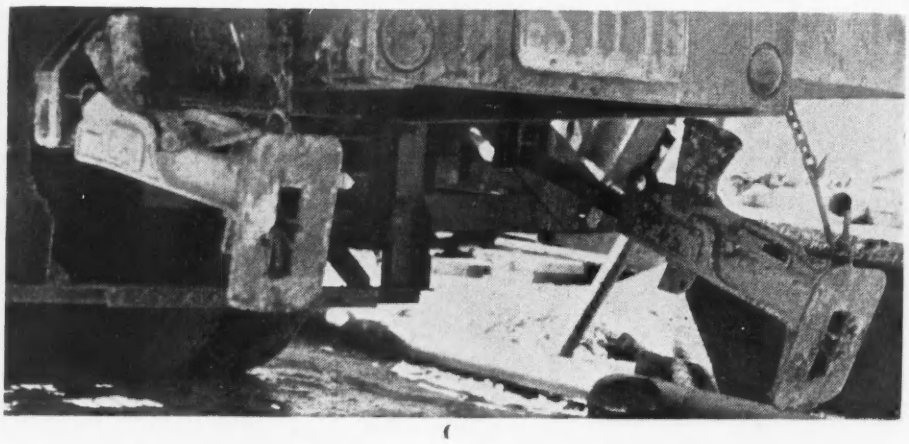
How To— Mount Jacks on Pulling Unit



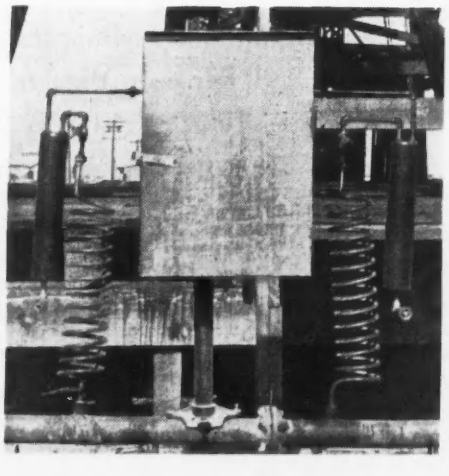
On pulling machines for servicing pumping wells, the jacks commonly used to carry the load of tubing and rods for the relief of springs and tires can be attached permanently to the unit and carried with it already in position for lowering and adjusting. A substantial bracket is welded to the well servicing unit on each side, or at as many places as jacks are required, so that the head of the stem can be attached with cross-head pins. When hanging free, the foot of the jack is near the ground, or concrete pad, and only the simple operation of the jack is necessary to support the load.

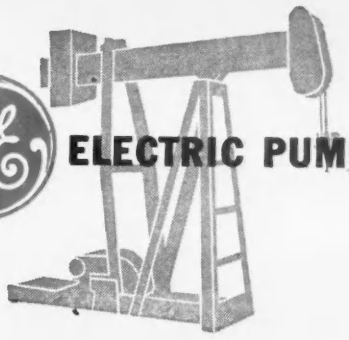
When moving from one well to another, a ring welded to the web above the heel of the jack forms a connection for hooking into by a carrying chain; the opposite end of which is connected to the frame, or body of the servicing unit.

How To—Stop Entrance of Liquids into Meter

Condensate and moisture in casing-head gas is frequently carried into the mercury chamber of field meters, resulting in inaccurate recordings and involved cleaning jobs. On a field meter which was cleaned regularly each week for a long period of time there was installed a pair of condensers which has operated to the satisfaction of the meter department. The condensers are each made of a full joint of quarter-inch pipe, cold-formed in the meter shop around a joint of three-inch line pipe. These helical coils replace the usual meter connections and condense all heavy fractions together with water vapor which drop out into the line again before they can be pulled over, by pulsation, into the mercury chamber.

An additional measure in the form of two scrubber chambers or settling compartments further aid in preventing any liquid from gaining entrance into the mercury bowl of the meter. These chambers are merely short sections of three-inch pipe closed at bottom and top except for the meter connections and drains. At the bottom of each section is a drain valve to make possible the removal of any condensed liquids which may accumulate there. Tops of both chambers are tapped with two openings; one to the meter, the other leading from the coil piping. With these added precautions against collection of liquids in the meter, accurate readings and trouble-free operations are assured.





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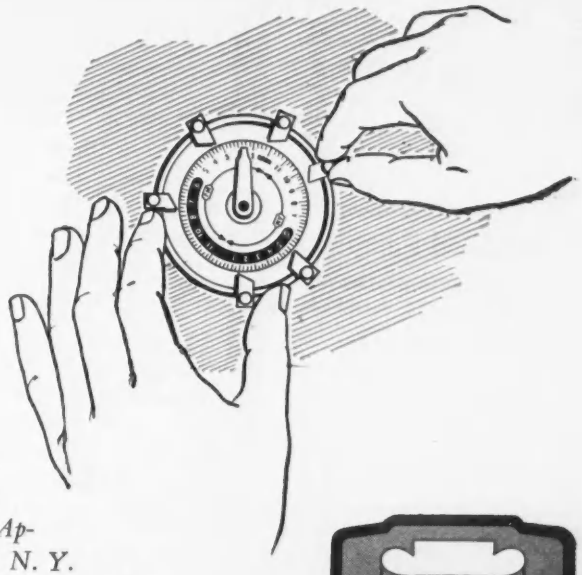

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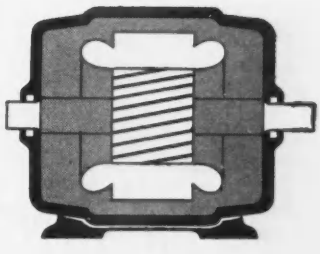

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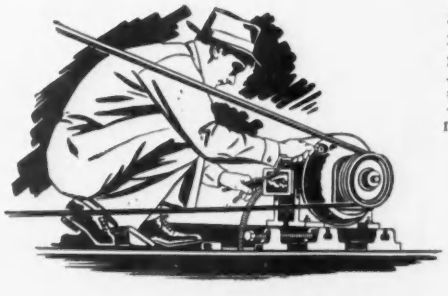

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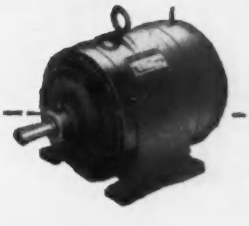

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How To—Collect Well Samples at Flow Line Manifold

An important phase in the production of a lease is that of checking periodically the base sediment and water content of oil produced by each individual well. One producer solved the problem of taking samples in a convenient manner by using stop cocks on the flow lines as shown.

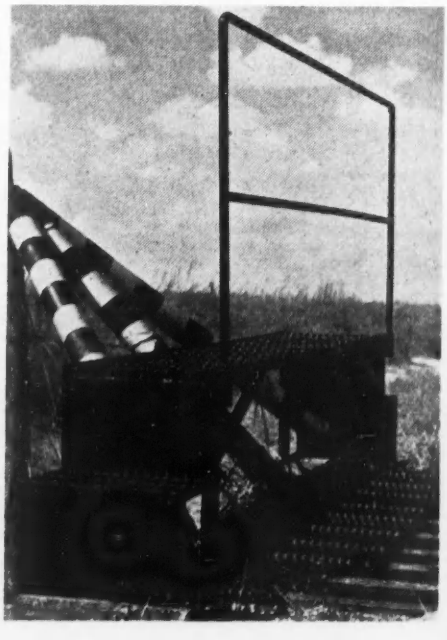
In the instance described, five wells flow into a common separator through a flow line manifold which is set above ground to permit manual control of each line. Immediately upstream of the plug valves on the flow lines are tees, the right angle connection of which are fitted with reducing sleeves and stop cocks. To the straight run of the tee is attached the check valve, then a reducer of the proper size before connecting to the manifold.

It is a simple task for the pumper to take well samples from any of the stop cocks, allowing the fluid to flow directly into the sampling flask. In this manner, he is able to check the BS&W content of each well separately, and thereby maintain a check on the performance of the individual well. In the background is the test separator manifold which is paralleled to the production separator, providing a means of testing the production from each well.

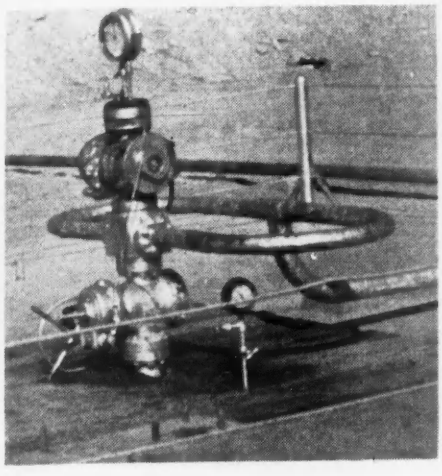
How To—Add Walkway to Cattle Guard

In wet weather, or when the switcher's shoes are oily, the round pipe used to form lease cattle guards is difficult to walk on, and may cause a serious accident. One company guards against this hazard by erecting a sturdy walk of corrugated metal across one side of the guard. This walk has two steps, so as to discourage use by cattle. A hand rail along one side adds still further to the safety of the walk.

The hand rail is formed to fit into sockets welded to the side of the walk, so that the rail may be lifted clear if a truck with an overhanging load is to cross the guard. The walk itself, being well below truck bed level, does not interfere with full use of the guard by trucks. The walk is supported at each end of the guard, and also has a bracket which is slipped over a bolt welded to the center section of the angle, striped section of the guard. This bolt is left loose so that the guard can sag under load without stressing the walk, but the fastening does act to prevent overturning of the walk.



How To—Install Expansion Loops at Well



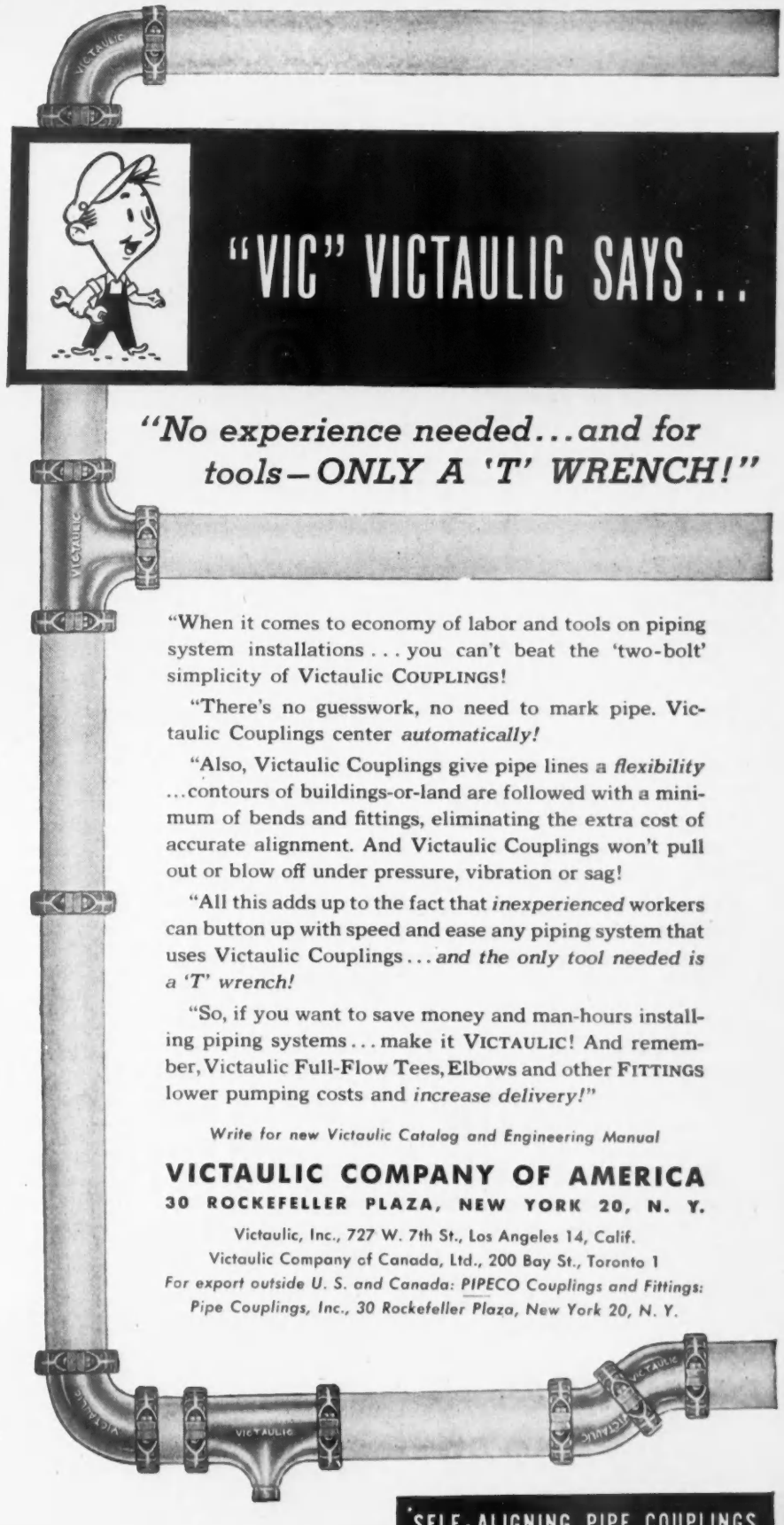
On a repressuring project employing high pressure with lines subjected to a wide atmospheric temperature range, provisions are made to absorb the smallest amount of expansion and contraction of the pipe at the well head. An oval loop is fashioned of pipe and equipped with welded-on companion flanges in one side of the loop to fit the openings on either side of the forged cross in the Christmas tree. The pipe carrying repressuring gas is attached by welding to the lower part of the opposite side of the oval pipe loop, rising from the supports away from the well with a long easy bend.

How To—Simplify Anchor Bolt Replacement

If the anchor bolt on a tank breaks, it must be replaced to prevent overload on the adjacent bolts. When the tank flange rests on the concrete, the broken bolt must be chipped out and a new one leaded in.

By welding ears on the side of the tank, eight inches above the base, and then welding a half cylinder to the tank, the ears are reinforced. The nut is not tightened down against the ear. A heavy washer is used between the ear and nut to cover the hole through the ear. This is made larger than the bolt to assist in placing the tank.

By raising the point of anchorage above the concrete, the bolt may be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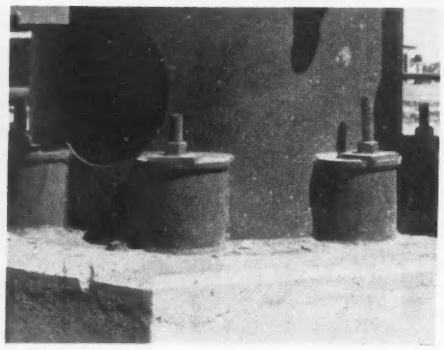

bent slightly to fit without damaging it. If the bolt breaks, a new end may be welded on. The half cylinder plate may be cut through with the torch, and the splice made through the hole. A cover or patch then seals the new bolt end against rusting.

How To—

Make Loss-Proof Line Rack

In carrying short lengths of rope, steel line and similar materials used on the pulling unit truck, one production crew has devised a simple rack which prevents lines from bouncing off their supports to become lost or badly entangled whenever very rough roads are traversed. On the side of the truck and flanking the front of the pulling unit engine, were installed two steel arms which extend outboard a sufficient distance to accommodate the wraps of material likely to be carried.

The outstanding difference between these arms and those usually employed for such service is the fact that the arms are provided with hooks which point downward instead of upward.

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VALVES, HYDRANTS

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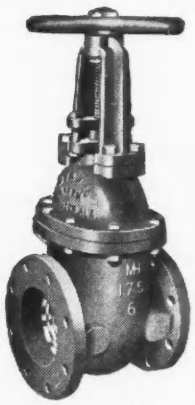

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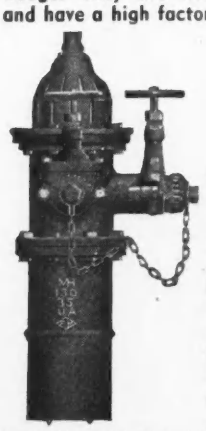

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Automatic Control on the PORTLAND-MONTREAL PIPE LINE

By C. D. BATCHELDER
Chief Engineer, Portland Pipe Line Corporation, and
R. A. ROCKWELL
Director of Engineering
Mason-Neilan Regulator Company

THIS ARTICLE deals with the Portland-Montreal crude oil pipe line, with particular accent on automatic control. This line was originally operated by full manual control. Reasons for the changeover to automatic control, results obtained with the new system, and development of the control equipment are discussed.

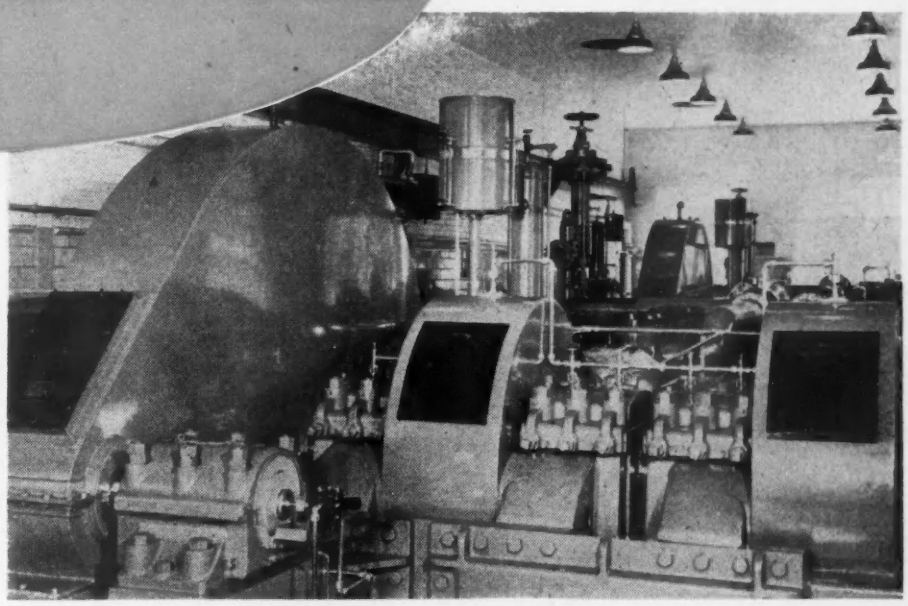


FIGURE 1. Pumps at Raymond Station.

THE Portland-Montreal pipe line was constructed during 1941 as a defense measure to provide year-round deliveries of crude to refineries at Montreal. Previously these refineries received deliveries direct by tanker during seven months only, as the St. Lawrence River is ice-bound during the five winter months. The line eliminates an approximately 2000-mile round trip by tanker, which was particularly important during the war when there was a shortage of ships and German submarines were very active along the Eastern Seaboard.

The main line is a welded line, 12 inches in diameter, built out of seamless pipe with a wall thickness of 0.375 inch. Total length of the line is 236 miles, 166 miles located in the U. S., crossing portions of Maine, New Hampshire and Vermont. The remaining 70 miles runs through the Province of Quebec from the International Border at North Troy, Vermont, to Montreal.

The Portland-Montreal line was financed and constructed by Standard Oil Company (N. J.) through subsidiary companies. The Portland Pipe Line Company, a Maine corporation, owned and operated the U. S. end of the line, and the Montreal Pipe Line Company, Ltd., a Canadian corporation, owned and operated the Canadian end of the line. Deliveries are made to the refineries at Montreal of The British American Oil Company, Ltd.; McColl-Frontenac Oil Company, Ltd.; Imperial Oil, Ltd.; and Shell Oil Company of Canada, Ltd.

In April, 1946, Standard sold its entire interest in the system to these four Canadian companies and at that time the four companies formed a new Maine corporation, Portland Pipe Line Corporation, which took over the assets and operation from Portland Pipe Line Company.

Crude is delivered by tanker at the new steel and concrete unloading pier at South Portland, Maine. This pier accommodates two tankers at one time and unloads up to 15,000 barrels of crude per hour. Tankers are unloaded either through a 24-inch line, approximately three miles long, to the tank farm where the first main line pump station is located, or through a 16-inch line to two storage tanks on shore. Oil unloaded into the shore tanks later is transferred with centrifugal pumps at the unloading station to the tank farm through the 24-inch line. Combined storage capacity of the waterfront terminal and the tank farm is a little more than 1,100,000 barrels.

Besides the initial station there are seven booster stations along the line, spaced about 30 miles apart. These stations handle up to 70,000 barrels of crude per day, discharging at a maximum pressure of 800 pounds per square inch, into the main line. Portland receives oil from 14 or 15 different fields in South America and the U. S. Mid-Continent, and the crude batched through the Portland-Montreal pipe line has a wide range of characteristics. During the war the line carried several emergency batches of aviation gasoline but now handles only crudes. Gravities range from 19 to 47 API, and viscosities from 34 to 1500 SSU (Cumarebo to Heavy Colombian).

In some instances crudes with a very high wax content are blended to lower the pour point, and in other cases high viscosity crudes are cut back with casinghead gasoline to improve their pumping characteristics. Crudes of this nature present a problem more or less peculiar to the Portland-Montreal pipe line. This line was an adventure with low temperatures; atmospheric temperatures in some locations drop to 50° below zero in winter, and oil temperatures in the line drop to 33° above. During the winter months a maximum allowable pour point of 20° is maintained to avoid the possibility of the oil in the line going solid if there should be a forced shutdown with a resulting temperature drop in the line. Should such a catastrophe occur, it is probable that the system would be shut down until the following spring. All outside work on the line is done during the summer, as the ground is frozen solid in winter and can be broken only with a pneumatic drill or a "concrete buster." Pipe liners out in the heavy snow have to carry skiis or snowshoes, emergency food rations, extra clothing and blankets

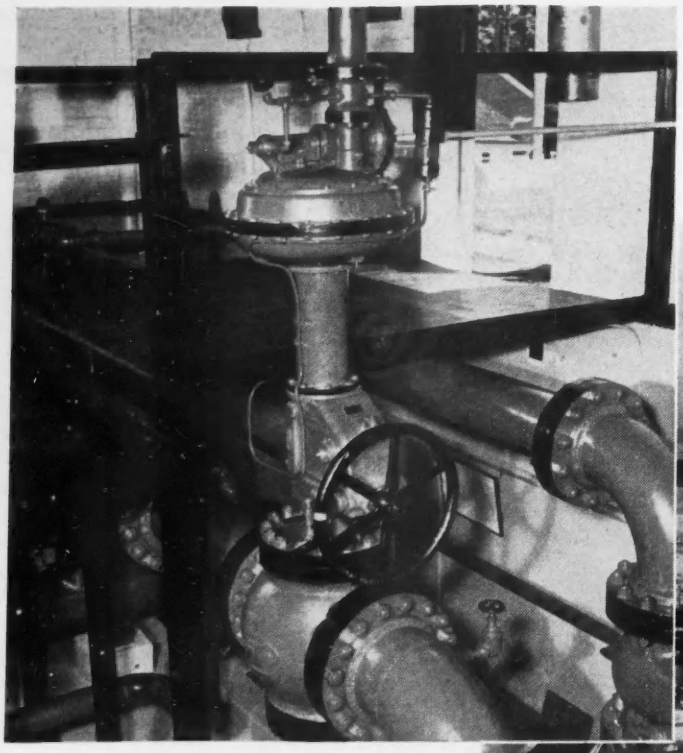
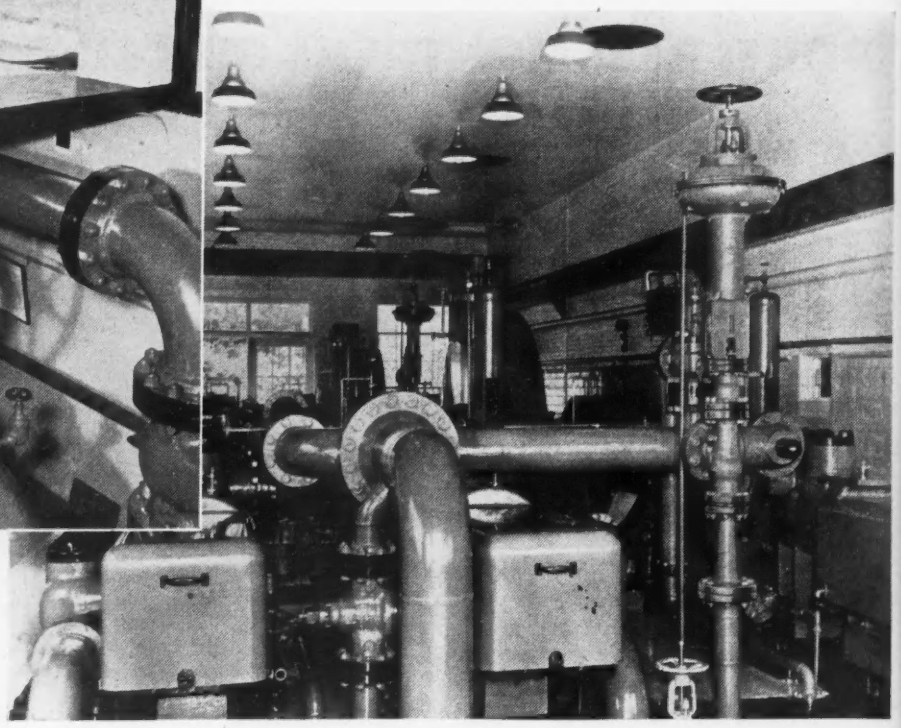


Figure 2—Pilot-operated back pressure regulator protects pump suction manifold.

Figure 3—Control valve in crossover line between suction and discharge headers.



and a host of special winter automobile accessories.

Of the eight mainline pumping stations, six are electric and two are diesel (where electric power supply facilities are inadequate). The motors are synchronous, unity power factor motors (with the attendant economies) rated at 500 horsepower, 327 revolutions per minute, 2300 volts. Of the diesels at the other two stations, two are 16¼ x 23-inch, 4-cycle, 6-cylinder heavy-duty engines for 600 hp at 225 rpm, and two are 500 hp at 225 rpm. Pumps are positive displacement, triplex double-acting plunger type. Fourteen are 6¾ x 27 inches, two are 7⅛ x 24. Fireproof walls with stuffing boxes for the shafts separate the pump rooms from the prime movers.

Operation of the Open System Under Manual Control

Originally, this line operated as an "open" system. A 30,000-barrel over-and-short tank at each booster station floated on the line. An eight-inch back pressure regulator maintained the suction pressure to the pumps at or below 20 psi. If the pumps could not handle the full throughput of a preceding station, the suction pressure would rise, partially opening the regulating valve and shunting the excess oil flow to the tank. The tank would then take on oil until the regulating valve closed up again, after which the contents of the tank would remain constant or would flow back through a check valve to the pump suction, if the suction pressure fell below the static tank head. The valve was large enough to route the full stream to the tank in case of station shutdown.

Operators formerly controlled station pumping rates by hand-operated plug valves on bypasses between the pump discharge and suction headers. This manual control system required constant attention by the station operators to maintain an even pumping rate, and it was the study of this problem that led eventually to adoption of the new control system.

First, the elevation profile of the territory through which the pipe line operates is such that between certain pump stations there are critical points, especially at the slower pumping rates. It can be seen that this condition would cause line surges. To alleviate this the station operators would adjust the pump bypass flow in order to reduce pump pounding and smooth out the pumping rate.

Second, the manual control system augmented the work of operators and dispatchers. The operator frequently had to adjust the hand lever operated plug valves on the pump bypasses up to a dozen times per shift as his dispatcher directed him. Every time an operator changed his bypass setting it would throw off all other stations, forcing them to readjust their pressures, and so on up and down the line. This gave the flow a long-term cycling effect. The operator had to observe his pressure records carefully and relay the data to the dispatcher, who would try to correlate the records of all stations and direct the operators accordingly. With the tanks in use the operators had to go outdoors and gauge the tanks hourly even in the roughest weather.

The third problem, and probably the most serious of all, was contamination. With as many as three different tenders of varying grades in the 236-mile line at one time, the over-and-short tanks would be intermittently mixing one grade of crude with another. With the station tanks on the line there was no positive way to eliminate contamination, although by careful operation it was kept to a minimum. This condition was particularly serious with lube stock being batched through, as any contamination seriously affected the refinery operation. The remedy for this was to operate as a closed system and do away with the over-and-short tanks.

These, then, were the reasons for the changeover to automatic control: to stop contamination of the various grades of crudes, to maintain a controlled suction pressure to the pumps, to limit the maximum discharge pressure and to simplify the operators' and dispatchers' work.

The purpose of a pipe line is to transport oil economically. Automatic control

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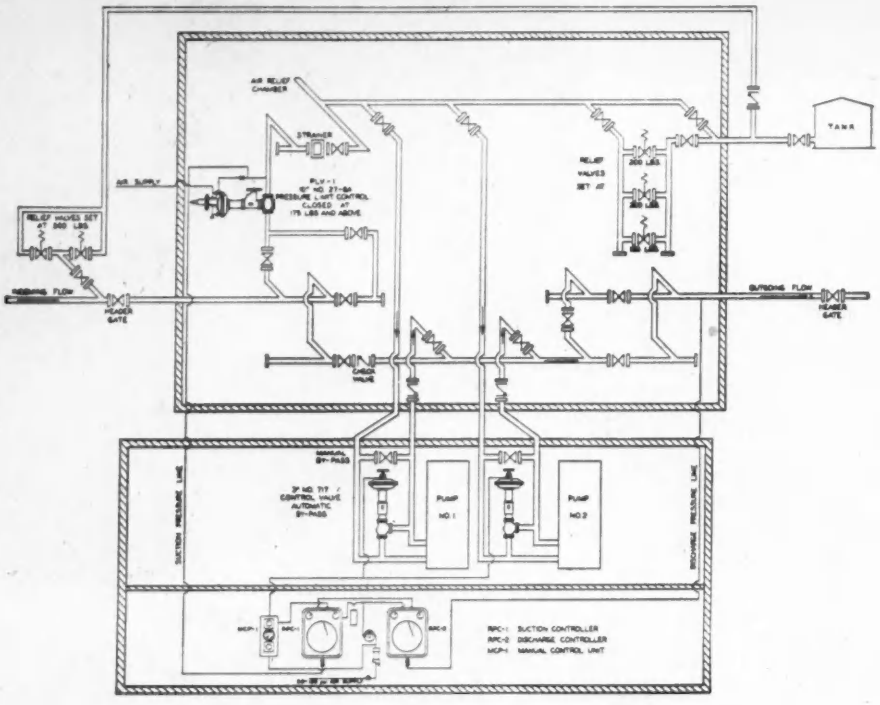

FIGURE 4—Control system at four booster stations.

must improve this transportation if it is to justify the initial and maintenance expense. Analyzing the requirements, it is desirable first to separate the functions best performed automatically from those that by design and operation of the pipe line are more simply and smoothly performed by manual adjustment. Complications necessarily added by the automatic control system must be justified by superior performance.

Except in a few highly specialized pipe line installations, operators must be in attendance at all stations. The responsibility for overall operation always remains in the hands of the operators. So the control system and the control mechanisms must be relatively simple so that the station personnel, whether regular or relief, can handle all ordinary operations and maintenance. The controls must be usable tools to assist the operator in performing functions far better than he can do with manual means. They should relieve the operator of the jobs that require continual tiresome adjustments.

The system chosen for automatically controlling the Portland-Montreal line is based on series operation of the suction and discharge controllers. This basic method has been used by a number of pipe lines, both refined products and crude, with the details of the equipment, installation and operation modified to meet local conditions.

This control system and its individual elements appear in Figure 4.

1. Control valves: The three-inch angle-type air-to-close control valves are installed in crossover lines between the suction and discharge headers. There are two valves at each station, one for each pump. These provide for suction and discharge pressure control on either or both pumps.

The valve has a diaphragm motor pressure range of three to 15 psi. That is, the valve is open until the controller output air pressure increases to three psi, when it will start to close. Further pressure increase progessively closes the valve until at 15 psi it is shut. Increased air pressure to the valve tends to close the valve, reducing the bypass flow around the pumps, increasing the flow through the station.

2. Low limit suction pressure control. The measuring element of the suction controller measures the suction of the station. The predetermined control point is set at about 25 psi or more, depending on the conditions at the individual station. The output air pressure of the discharge controller is the air pressure supply to the suction controller.

Assuming that the discharge pressure is below the control point of the discharge controller (about 800 psi), the output pressure of this controller is always the same as its air supply pressure—in effect, the discharge controller is bypassed. When the suction pressure is over 25 psi, the output air pressure of both suction and discharge controllers is 15 psi; therefore, the control valve is shut.

If the suction pressure begins to drop below 20 psi, the suction controller immediately reduces the air pressure to the three-inch angle valve. This opens the valve when the air pressure is below 15 psi, thus bypassing back to suction some of the outbound oil flow.

The range of the recording and controlling pressure instrument is 0 to 250 psi, with protection for 100 percent overload or to a total of 500 psi.

3. High limit discharge pressure control. The measuring element of the discharge controller measures the discharge pressure. The predetermined control point is set at about 800 psi.

Assuming that the output air pressure from the suction pressure controller is 15 psi, the output air pressure from the discharge pressure controller is also 15 psi as long as the station discharge pressure is below the control point of 800 psi. Therefore the valve is shut.

If the station discharge pressure begins to exceed 800 psi, the discharge controller immediately decreases its output air pressure to the control valve. This increases the bypass flow to suction, limiting the station discharge pressure to 800 psi.

4. Series operation of the suction and discharge controllers. Either the suction or discharge controller may govern the actual opening (exposed area) of the control valve, but never both at the same time. The maximum air pressure to the control valve diaphragm is 15 psi. Either controller can reduce this pressure, and the controller that establishes the lower output air pressure governs the valve opening.

5. Independent nozzle air supply pressure on suction controller. When the discharge controller comes into operation, the control mechanism of the suction controller is completely bypassed. At this time the output pressure from the discharge controller is the only supply pressure available for the pilot and nozzle. If the output from the discharge controller is below 10 psi the nozzle and pilot operation is sluggish; below seven psi, they are inoperative. Therefore, an independent nozzle air supply of 20 psi is brought to the suction controller.

Operation of the Portland Line Control System

The major functions of the control system are to: (1) set and maintain within limits the throughput of the initial station at Portland; (2) adjust the individual booster station pumping capacity to the throughput of the initial station at Portland; (3) limit the minimum booster station suction pressure (inbound); (4) limit the maximum booster station suction pressure (inbound); (5) limit the maximum station discharge pressure (outbound).

The originating station at Portland sets the discharge control to maintain an optimum constant discharge pressure. This determines the pipe line through-

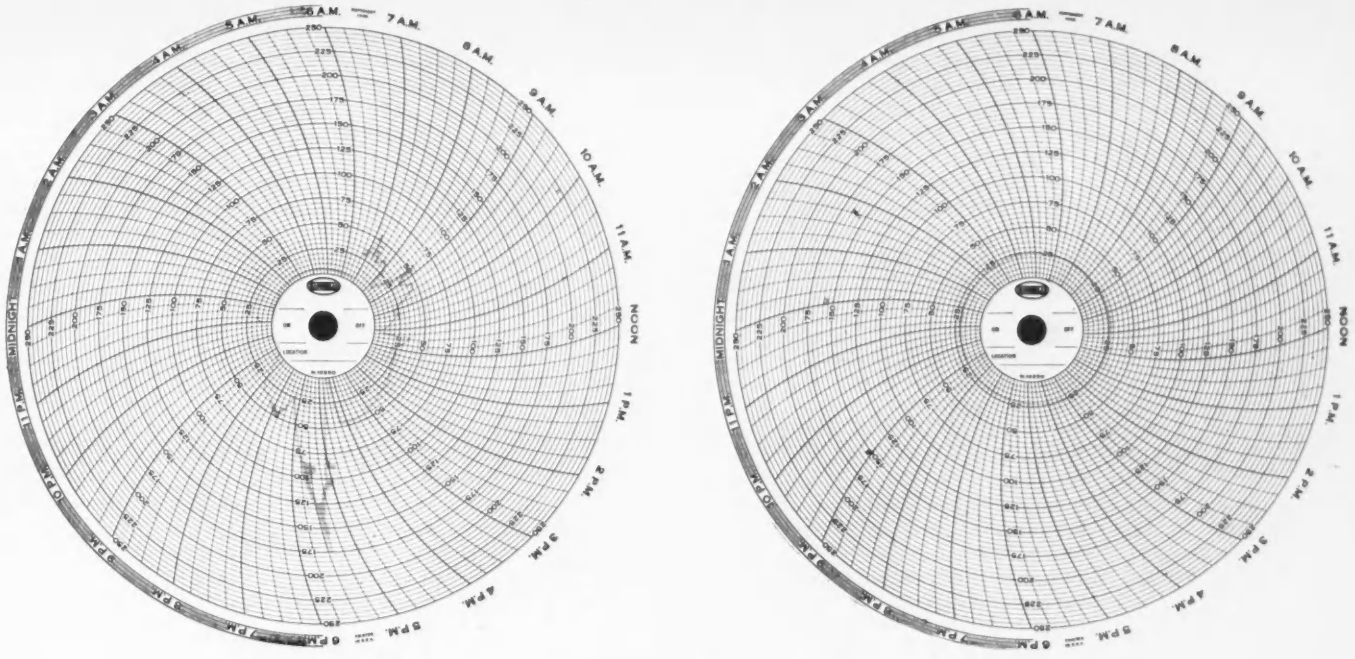

Figure 5—Suction pressure records: Left, manual control; right, automatic control (closed system).

put. Under constant operating conditions a fixed discharge pressure will hold the flow constant. Variation in flow results when tenders with different viscosities are introduced. The change in flow from one tender to a second tender is gradual as the first tender becomes displaced in the line. The discharge controller gives the operator a simple means of setting the precise discharge pressure and the line throughput.

Unless operating conditions are such that there is a bottleneck at some booster station, all stations normally operate on suction control. When the suction pressure is held contant, the booster station pumps out all that comes into it. If the flow entering a station increases, the suction pressure tends to increase and the controller further throttles the valve (Figure 3) in the bypass around the pump. This increases the station pumping capacity to match exactly again the quantity entering the station. Thus any change in throughput made at Portland causes all booster stations to adjust their pumping capacity to match. This is the only way a closed system can operate.

Holding the suction pressure to a minimum permits the line to operate at the lowest static pressure permissible with the line throughput. The suction pressure must be held to a positive value for the pump to fill properly on the suction stroke, otherwise pounding results. The suction pressure at various stations frequently is set at different values, depending on the hydraulic gradient of the line entering the station.

In order to protect the pump suction manifold against high static pressure a ten-inch pilot-operated back pressure regulator (Figure 2) functions on the suction line to the pump. This regulator is set at 175 psi and as long as the pressure is below 175 psi the valve is wide open. If the suction pressure tends to exceed 175 psi, the regulator closes as required to prevent further pressure increase. When the incoming line pressure exceeds 185 psi the relief valve opens, relieving to tankage.

The discharge controller setting establishes the maximum discharge pressure. When the pressure tends to increase beyond this setting the discharge controller opens the pump bypass valve as required to limit the pressure.

Selection of Type of Control Equipment

In selecting the type of controller to be used, the major considerations were ruggedness and simplicity. Both the suction controller and the discharge controller are "proportional controllers," without reset. The use of reset would permit a constant control point under load change where the proportional controller allows the control point setting to vary, and the setting index does not always indicate the exact control point. Reset was avoided as its disadvantages outweighed its advantages. First, it adds complication in requiring two stabilizing adjustments instead of one. As far as line operation is concerned, it is important that the controller level out the pressure and flow following any change as quickly and smoothly as the pipe line system will permit. Rocking the line and nursing pressure waves should be avoided. It is true that with proper adjustment of the reset rate (very slow rates) stability can be achieved with reset. However, with stations spotted from Portland across the border into Montreal, it seemed impractical to introduce the intricacies of reset into isolated stations where skilled instrument service would be very hard to get.

The major reason for not using reset, however, is that the suction and discharge controllers are interlocking controllers operating the same control valve (see Figure 4). In operation, either the suction or the discharge controller positions the bypass control valve. The controller that is not operating the valve is bypassed with either full supply pressure or the diaphragm pressure equalized in the reset control system. If operating conditions then require the controllers to swing from suction to discharge control or vice versa the position of the proportional band may be at any location with respect to the setting index, and appreciable deviation in pressure may result until the reset has had time to balance out the control point. The proportional controller has the advantage that the proportional band remains fixed with respect to the setting index. Its operation is never discontinuous, which is not true of a reset controller balanced at a 20 psi supply pressure when the control valve is fully closed at 15 psi.

The only way to vary the capacity of large constant speed positive displacement pumps is to bypass the flow from the discharge header to the suction header. This is a tough control valve application. The required valve capacity is large and the pressure drop across the valve is appreciable. The normal discharge pressure is 600 to 800 psi. The

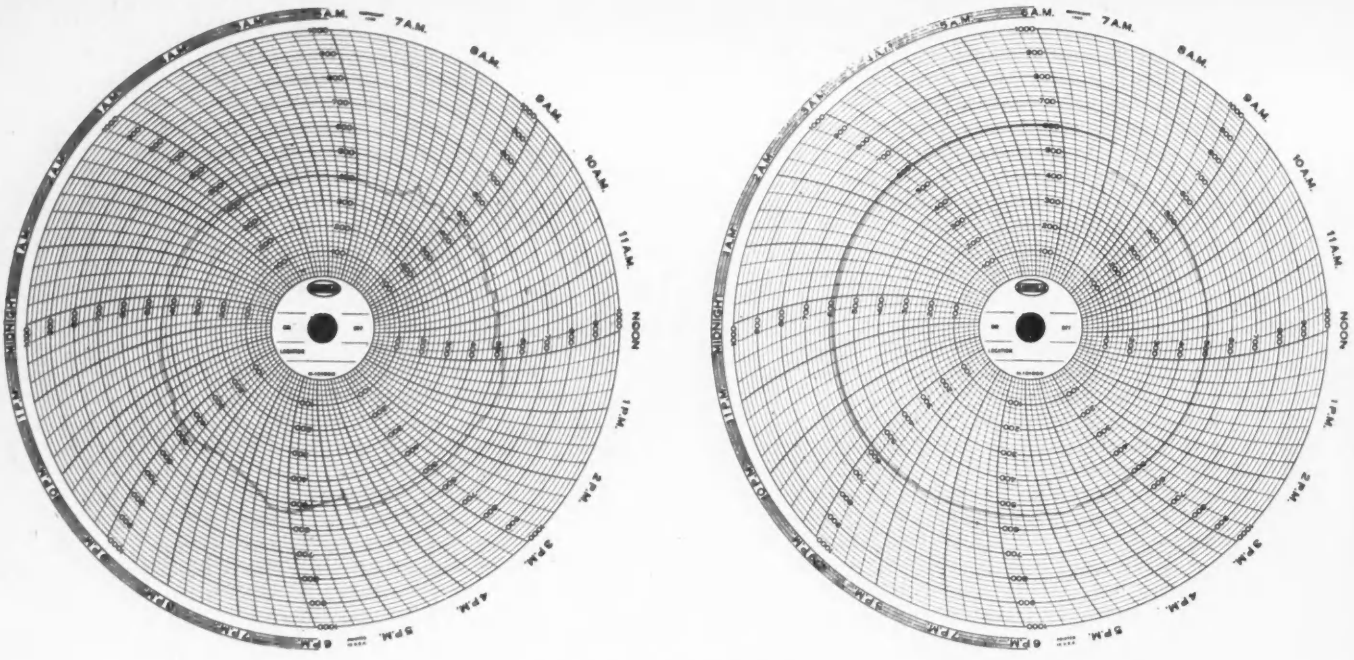

FIGURE 6—Discharge pressure records: left, manual control; right, automatic control (closed system).

normal suction pressure is 25 psi. The pressure drop across the valve is thus 575 to 775 psi. The control valve employed (Figure 3) is a three-inch angle-type valve with heat-treated stainless steel trim, hardened to a Brinell of 500 or a Rockwell C of 50. The handwheel shown on the diaphragm motor is for setting the opening of the valve manually. The three-inch valve has a reduced area port, and is chosen to give a maximum of 25,000 barrels per day at 600 psi pressure drop in the full open position.

Cavitation is one of the serious problems met when control valves operate on liquid service under high pressure drop. Excessive erosion in valve body trim and adjacent piping mark the cavitation condition, and in this case there also was a rumble and vibration with unbearable noise. Extensive experimental work was done in the hydraulic laboratory and at the booster stations to determine the valve plug contours and the piping arrangement to produce a quiet and satisfactory valve for this service.

Performance of the Pipe Line Under Automatic Control

After this treatment of the control system and control equipment it is in order to look at the results of operating the pipe line by automatic control. Six months of operation under automatic control show results which are most satisfactory. The charts in Figures 5 and 6 contrast pressure records made under automatic control with those taken from manual control of the closed system.

The charts in Figure 6 are records of the suction pressure at the North Waterford Station. Chart dated April 13 is a record showing manual control with the pipe line operated as a closed system. Manual control meant adjusting the position of the plug valve in the bypass around the pump, based on constant observation of the suction pressure. Chart dated May 13 is a record of suction pressure under automatic control.

Figure 6 shows records of the discharge pressure with the station under manual and then automatic suction control. Notice how the discharge pressure under manual suction control varies, reflecting the pattern shown in the suction record. The discharge on automatic pressure control again reflects the general characteristics of the suction pressure, indicating smoothness in line operation. The gradual increase in discharge pressure beginning at 9 a.m. is the result of a change in tender.

The dispatcher's work is now much more pleasant. His problem now is to direct the output of South Portland, the initial pumping station, so that the station of least capacity can handle the throughput while there is minimum energy loss through throttling valves in the system. To cut back on the throughput, the initial station merely resets the control point of the discharge pressure controller to a lower value, and does the same during transition from a high viscosity to a low viscosity tender.

With this system the over-and-short tanks will serve during scraper operation. About every two to three weeks the scraper is started through the line, and the tank at the next station goes on the line just before its calculated arrival. The tanks at the first two booster stations are connected to relief valves on the incoming line, so that in case the suction pressure exceeds 185 psi, the crude flows to the tanks. Should either of these stations have a .shutdown, the incoming stream is bypassed to the next station, with a decrease in throughput of approximately 33 percent. The tanks now are blocked off and serve only as insurance in case of emergency.

One expects that the pipe line management and engineers would approve a control system such as this because they can see the overall advantages in it and see that uniformity of operation pays off. But the engineers do not have to operate the booster stations, do not experience the strained watchfulness, physical exertion or exasperating repetition of movement necessary to manage a station under manual control or under a poorly integrated automatic control system. Nor do they have to cope with the maintenance and adjustment of a highly complex control system. The station operator is the man who lives with the control system, and his independent opinion of its operating merits has an importance all its own. When the new control system was first put in, the Portland pipe line operators were somewhat skeptical, but after a short period they found the automatic control to be a practical working system.

TANKER TRANSPORTATION

And Inland Waterway Operations

WATER-BORNE handling of petroleum, either crude or as finished products, forms an important part of the transportation system of the industry. The author summarizes the present status of tanker and inland-waterway operations.

The T-2 tanker in war service not only carried a full cargo in all tanks, but also transported vast tonnages on deck of commodities ranging from drummed petroleum products to heavy users of the vessel's cargo, such as tanks, planes and amphibious vehicles. With resumption of peacetime trade, the T-2's have been stripped of the overhead cargo gear, and are concerned only with liquid ladings.

By M. G. GAMBLE,
Standard Oil Company (N. J.)

THE transportation of oil by tanker in much the same manner as we know it today began in 1886 with the construction in a British shipyard of the S.S. "Gluckauf." Since that time considerable progress has been made in hull and machinery design, and much more is in prospect; but the principle of carrying oil in tanks extending to the skin of the ship in a large seagoing vessel has remained the same over these 61 years, and there is little likelihood of this form of ocean transportation meeting any serious competition in the future.

The earliest form of deep-water transportation of petroleum was by means of cases and barrels loaded on barges and in dry-cargo sailing vessels. This method was followed by an earlier type of tanker which contained separate steel tanks with an air space under and around them. The chief objection to this type was the tendency of explosive gases to collect in the spaces around the tanks, with consequent danger to personnel and equipment. The Gluckauf type obviated this danger, and at the same time provided much greater simplicity of construction.

Tankers in Two World Wars

In a general discussion of tankers it is interesting to review and compare the tanker-tonnage situation during and after the two world wars. In 1914 the total world tanker fleet consisted of little more than 2 million deadweight tons, about 87 percent under foreign flags. However, due largely to construction in U. S. yards, the world tonnage by the end of 1921 had increased to about 7 million tons, more than half under the U. S. flag. But unlike the situation today, U. S. government-owned tankers accounted for only about one-fourth of the U. S. flag tonnage. A business depression then set in which, coupled with low-cost construction in European yards, brought building in U. S. yards to a standstill. In the period from 1921 to 1929, foreign-flag tonnage increased about 150 percent due to construction in Europe, while in the U. S. we were struggling to absorb the American-flag surplus.

In 1929 and 1930, it began for a time to look as though U. S. tanker construction would again come into its own, but once more a serious business depression called a halt. By 1935 the U. S.-flag tanker fleet had dropped to about 30 percent of the world tonnage, and consisted mostly of vessels approaching obsolescence. Although there was a gradual rise in the construction of tankers from that year, the pace of building in U. S. yards did not approach that in foreign yards until 1941. In the year following, submarine warfare reached its peak; U. S. ship construction was stepped up rapidly, and for the first time since World War I, tanker construction in this country exceeded that in foreign yards. The bulk of our war-built fleet

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was constructed during the next three years. Today, as in 1922, more than half of the world's tanker tonnage is under the U. S. flag, and again, as in that year, building here has practically reached a standstill. On the other hand, tankers under construction, or on order in European yards, now total about 180, most of which are being built in Great Britain and Sweden. Deliveries in foreign yards reached a total of 58 tankers in 1946, and 17 have been reported so far this year.

Present Shortage

The foremost question within the industry today on the subject of tankers is "Are there enough tankers?" If there are, "why are we experiencing such a transportation shortage as now exists?" The correct answer to the first question, I believe, is that there are ample tankers in the world today. As of October 1, there were approximately 96 U. S. government-owned T-2 type vessels in tieup over and above the 200 in operation. In regard to the second question, the prolonged shipyard strike has kept a substantial number of tankers out of service. Several months have been required in most cases to process the purchase by private industry of T-2's from the U. S. Maritime Commission. Also, both military and commercial requirements have proved to be far in excess of previously estimated needs. All these factors, I think, explain why, in spite of there being enough tankers, we are at present handicapped by an artificial shortage of water transportation.

We are glad that steps now are being taken to break all modern tankers out of tieup, and feel that there is ground for hope that the shipyard strike will be terminated in the near future. There are now indications that practically all U. S. Maritime Commission-owned tankers not required by the government services will be sold promptly either to Americans or foreign buyers. However, it is difficult to foresee when these steps will be effective in ending the transportation shortage. As vessels taken out of tieup for sale or operation require repairs, the shipyard situation will largely govern the speed with which the shortage can be alleviated and finally overcome.

From a long-range standpoint, it is felt that building in Europe—which apparently is being greatly retarded by material and labor shortages—will not, in itself, provide all tonnage needed to keep pace with world requirements, and construction in U. S. yards will, therefore, be necessary.

For national-defense purposes tankers should be fast, modern, and efficient in order to minimize the risk from enemy action and to insure prompt delivery of cargo. No less is this true for economical commercial operation. It is fortunate, therefore, that the government is promoting sales to legitimate buyers for foreign industry, as this will provide an opportunity in the future for modernization of the U. S.-flag tanker fleet.

About the Author

M. G. GAMBLE was born in Louisville, Ga., and graduated from the U. S. Naval Academy in 1915. He joined the Standard of New Jersey company in 1919, in the construction and repair devision of the marine department. In 1937 he was made assistant in the traffic division; and in 1938 he became manager of the Caribbean division. He became assistant general manager of the marine department in 1942, becoming general manager in 1945. During World War II he was active in coordinating operations of the Standard Oil Company (N. J.) tanker fleet while under requisition to the War Shipping Administration.

War Construction

The war resulted in the loss of about 40 percent of the prewar worldwide tanker fleet. However, it also had the effect of hastening the general utilization of larger and faster ships. For example, the average prewar American-flag tanker had a deadweight tonnage of about 11,500 and a speed of about ten knots, whereas today the average American tanker has a deadweight of about 15,000 tons and a speed of 14 knots. In general, we might safely say that the size and speed of a tanker, within certain limits, are all-important in reducing operating costs. This is particularly true with today's high and rising costs.

Our government constructed during the war about 9 million tons of T-2 type tankers. These vessels have a deadweight of about 16,600 tons, a speed of 15 knots, and a capacity of 138,000 barrels of gasoline. In most trades oil can be transported in them about 25 percent cheaper than in a prewar 13,000-ton, 12-knot tanker, and for about 30 to 40 percent less than on the old 11,000-ton vessels. Looking at this question in another way, it is estimated that out-of-pocket operating costs have about doubled since 1939. However, the increased size and speed of the modern fleet, with consequent increased haulage capacity, has fortunately reduced the cost per ton-mile, so that the effective rise on that basis has only been about 65 percent.

New Tanker Types

Inasmuch as it is obvious from the foregoing that large, fast tankers are an answer to the high cost which owners—and, I might say, particularly American owners—are experiencing today, the question naturally arises as to how far one should go in this matter of size and speed. Since difficulties have been experienced in accommodating T-2 tankers in many ports, some may question the advisability of going to still larger ships. However, various waterway improvement projects already carried out or in progress by the U. S. Army Engineers, coupled with terminal improvements by private companies, have greatly improved this situation. Recent studies made on this subject by our technical staff have led to the design of a 26,000-ton 16-knot vessel with a length of 628 feet and a draft on summer freeboard of 31½ feet. This is felt to be the most practical answer to the foregoing question. The draft, which is only slightly more than a foot above that of a T-2, will permit this large vessel to enter the majority of ports which can accommodate T-2's with full cargo. The cargo tank capacity, after making the usual allowance for expansion, is about 228,000 barrels. It is estimated that transportation costs on such a vessel would be about 20 percent less than on a T-2. Naturally, the use of this size of tanker will involve some sacrifice in flexibility, both as regards the grades that may be carried and the terminals at which they can be accommodated. In the early stages, these vessels probably would be used principally with fuel oil and crude; but, with the present upward trends in the volume of petroleum products consumed, it is a safe assumption that, as time goes on, they will be used to an increasing extent for the transportation of products. Also, as vessels of this size increase in use, they will be taken into account in the design of future terminal

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facilities, and in the improvements in existing ones both here and abroad.

Operating Costs

Just as high operating costs highlight the need for large fast tankers, so do these high costs (many of which go on in port the same as at sea) accentuate the need for quick turnaround. The average cost of a T-2 at the dock is about $1800 per day, which gives some idea of the importance of keeping port time to a minimum. Given the proper shore facilities, a modern tanker is capable of loading or discharging at a rate of at least 10,000 barrels per hour. It is in the common interest of all concerned, therefore, including suppliers and consignees, to provide loading and discharging facilities with the maximum capacity justified by the volume handled. In normal times, when rates follow closely the market situation, the charterer with a reputation for quick turnarounds will be favored over others. Another factor which may react to the charterers' benefit is the covering of their requirements well in advance and for as long a period as practicable. Over the long run, rates reflect the owner's costs; and it is, therefore, in the interest of all concerned to keep these costs to a minimum.

Let us now turn from the subject of ocean tankers and discuss briefly inland-water operations in the U. S. Here there are more than 26,000 miles of navigable waters. Of this total, 9200 miles, or about 35 percent, have a depth of nine feet or more; and 14,300 miles, or about 54 percent, are six feet or more in depth. The remainder have depths less than six feet.

Inland-waterway transportation began at the time oil was discovered in Pennsylvania in 1859. Oil was then moved on rafts, which were steered by poles and floated with the current from the upper reaches of the Allegheny River to the Pittsburgh area. Since this early beginning, transportation has evolved until in recent years large single barges, or groups of them in flotilla, are towed or pushed in our inland rivers. On other waterways, where deeper drafts are possible and other considerations favorable, small self-propelled tank vessels are used. However, by far the greater volume is still transported in non-propelled equipment.

Non-propelled Equipment

One might ask why greater utilization is not made of self-propelled equipment. The answer, as far as our own operations are concerned, is that, in the majority of river operations, the greatest economy lies in the use of non-propelled equipment handled by powerful pusher-type towboats, and in certain other operations barges towed by conventional tugboats give better results. The latest type of river towboats has a horsepower of 2000, and pushes twelve 9000-barrel barges, making a total capacity for one tow of 108,000 barrels.

With a tow of this kind, one or more barges are released as terminals are reached on the route, and the towboat with the remaining barges continues on the voyage, thereby avoiding the laying up of the power plant while barges are being discharged, as would be the case with a self-propelled barge. When a sharp bend, coupled with a narrow channel and perhaps a swift current, makes the going hazardous, the majority of the barges may be moored while the towboat takes one at a time over the difficult crossing. Also, additional barges of suitable type and draft may be rented for use with the tow as occasion requires. In our western-rivers operations, the usual permissible draft is in the neighborhood of nine to ten feet, which, coupled with other local conditions, is not satisfactory for economical self-propelled barge operations.

On the Gulf Intracoastal Canal and, to some extent, along the inland waterways of the Atlantic seaboard, barges towed by small tugboats of the type seen around New York Harbor are commonly used. Tugs and barges have, in the majority of cases, also been found to be the most economical units for bunkering large vessels. This is because of the length of time consumed alongside the ship being bunkered and the consequent saving of the power plant's time. This saving is especially important today with the prevailing high wages.

Again referring to our own company's operations, in the Chesapeake Bay, the Erie Canal, the New York State Barge Canal, and the Great Lakes, as well as for short coastwise trips on the north Atlantic seaboard, conditions are favorable for the use of self-propelled equipment. Such of our equipment now in use consists of six self-propelled diesel barges ranging in capacity from about 600 barrels to 13,700 barrels. Our people are now taking steps to acquire larger units with capacities of more than 18,000 barrels for use in the New York State Barge Canal and on the Great Lakes.

Barge transportation costs vary with the volume involved in each shipment, the distance covered, the efficiency of the unit used, and the extent of delays at terminals and in transit. Where conditions are favorable for the use of self-propelled equipment, the larger and faster the vessel up to limits governed by local conditions, the lower will be the transportation costs.

In any new inland-waterway operation where a choice must be made as to the type of equipment to be used, the right decision can only be reached after a careful study of all the factors involved. Among these are:

1. The physical characteristics of the waterway, i.e., whether open but "easy" water, open with strong current, locks present; or whether there are shallow crossings with swift currents, sharp bends, etc.
2. Kind of terminal facilities available at loading and discharging ports.
3. Volumes to be handled annually.
4. Size of deliveries.
5. Generally accepted local competitive transportation practices.
6. Labor and other costs.
7. Special regulations governing the use of waterways.

Taking all of these factors into account, an economic study is made to determine the most advantageous and economical type and size of equipment for the intended service.

Among the advances made in recent years in barging equipment are the following:

1. Improvement in the lines of non-propelled barges: For many years short stubby rakes at the bow and stern were used. The latest design in these barges employs the so-called "Dravo hull," which has been developed after exhaustive model basin tests. With this design, the rakes at both ends are longer, but the stern is designed in such a way as to facilitate the clearance of water and the elimination of drag.

2. The stern-wheel towboat, so long in use on the Mississippi River and tributaries, and very aptly described in a recent issue of *The Lamp* under the title "Big Mama," is being replaced gradually by a more powerful pusher-type towboat with finer lines and conventional twin screws. Two of the new type are now being built for our company.

3. As time goes on, no doubt there will be a more extensive use of twin-screw self-propelled barges of from 15,000 to 20,000 barrels capacity, with speeds up to 12 knots and drafts of more than 12 feet.

Water-Transport Advantages

In conclusion, I should like to stress the advantage of water transportation from the standpoint of flexibility wherever conditions are favorable to its use. Both ocean tankers and inland-waterway equipment can be readily moved from one area of operation to another to suit changed conditions. As petroleum becomes more extensively used throughout the world, the need for its transportation by water gains increasing importance, and today the best estimates of normal postwar shipping show tankers comprising almost half of the total U. S. merchant fleet.

OF HIGH YIELD STRENGTH SEAMLESS LINE PIPE

By A. B. WILDER and J. D. TYSON
National Tube Company

BETTERED CORROSION protection practices permit present-day line pipe to be manufactured to meet service conditions without the need for providing excess metal to offset corrosion losses. As a result, pipe steel is being engineered to usage specifications. This article reviews new pipe materials and outlines applicable welding techniques.

STEEL has been used almost universally for pipe line construction, and one of the most important developments in the application of this material has been the field welding of joints. It is the generally accepted practice to weld line pipe without preheat, a postheat or backup strip. Such practice, however, requires a proper steel and welding technique.

In addition to providing a suitable material for welding, it also is important to consider the proper tensile properties of the steel. Under suitable welding conditions, it has been developed recently that steel melted to 0.40 percent maximum carbon and 1.40 percent maximum manganese with a minimum yield strength of 52,000 pounds per square inch may be used for pipe lines. A steel of this type may be economically produced in large diameter seamless pipe.

This investigation involves the study of the properties of a new grade of seamless line pipe with a 52,000 psi minimum yield strength and 75,000 psi minimum tensile strength. In the manufacture of the seamless pipe, the approach to these requirements involved the use of carbon and manganese. Due to the fact that current practice in the manufacture of seamless line pipe has been limited to 0.30 percent maximum carbon, 1.25 percent maximum manganese with a minimum yield strength of 42,000-45,000 psi (depending on the wall thickness), the application of seamless pipe with a minimum yield strength of 52,000 psi involves a number of problems due to appreciable increase in strength characteristics.

Upon the basis of extensive experience in the production of seamless casing with a minimum yield strength of 55,000 psi, it was concluded that the physical property requirements of the new grade of seamless line pipe could be obtained by melting steel to 0.40 percent maximum carbon, 1.40 percent maximum manganese. Steel of this type was rolled suc-

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cessfully into 26-inch diameter seamless pipe and satisfactory tensile properties were obtained.

Circumferential welding of full pipe sections was used in this investigation. The pipe was rotated and manual metallic arc welded with coated electrodes in a down-hand position. After tack welding, a root or stringer bead was applied, followed by a filler bead and finally a face or cover bead. Tensile tests of the original pipe and plate material were conducted in accordance with Specification API 5-L. In the bend test, pressure was applied in a tensile testing machine until a crack appeared or until completion of a 180-degree bend. The Vickers hardness tests were conducted with a 1 and 10 kilogram load on a standard Vickers hardness tester. Hardness tests were also made with an intermediate DPH tester. Other tests included X-ray and metallographic examination of welds.

To reduce some of the variables associated with manual metallic arc welding, weld bead tests were made at the U. S. Steel Corporation Research Laboratory. These beads were deposited with an automatic welding head with a stick electrode attachment. The hardness and microstructure were studied.

Bend Test Technique

A weldment of 52,000 psi minimum yield strength material should not be expected to have the same bending properties as a weldment of 35,000 psi minimum yield strength material due to the difference in minimum elongation. The conventional bend test for low yield strength material is not truly applicable to sound welds of high yield strength material. If a test of this type is to be applicable for all types of welded line pipe joints, there should be some modification which more clearly recognizes varying levels of ductility, depending on the strength of the material tested.

The cover bead in the tensile test of line pipe welds reinforces the weld and strengthens the heat-affected area, but is detrimental in the bend test, due to stress concentration associated with the notch effect. Lack of proper penetration or excess metal in the root bead also develops a notch effect which is harmful. In order to evaluate these factors, a number of special bend tests were performed. In the face bend test of high yield strength pipe, grinding the cover bead to eliminate notches improved results. Grinding the root bead is beneficial in the root bend test if a notch is present. In the root bend, grinding of the cover bead decreased the reinforcing effect of this bead and adversely affected the test results. There was no appreciable difference in the bend test results of normal yield (35,000 psi) pipe.

Although ordinary line pipe is not preheated or postheated during welding, pipe temperatures may vary. Preheat has little effect on the bend test results due to the loss in temperature during welding. Postheat showed possible improvement in bend test results and this may indicate the metallographic structure adjacent to the cover bead is affected by the postheat treatment and the residual stresses may be more completely removed. No appreciable differences in bend test results were found in pipe temperatures of 25 to 250° F.

Types of Weld Rod Combinations

In the welding of ordinary line pipe, a low tensile rod is generally used. The cover bead with reinforcement strengthens not only the cross-section of a weld in the tensile test, but in addition is responsible for a special type of stress distribution developed in the bend test. Special consideration with reference to bend test results should be given to the weld rod combination used in the welding of high yield strength line pipe. The shape of the weld beads used for high yield strength line pipe welds was similar to the practice used for ordinary line pipe.

All of the weld rods were coated. The lime-base coated rod was not included since additional development work is necessary before this rod is applicable to all-purpose welding. The influence of hydrogen on the cracking susceptibility of steel is recognized and, although the commercial aspects of the low hydrogen rod place certain restrictions on its use in line pipe welding, the technical significance of this development is of general interest.

Little difference was observed in the root bend tests with various types of weld rod combinations. Variation in the face bend results were obtained. It was observed that when a high strength rod is used in either the first or second beads and covered with a soft rod, the face bend tests were generally poor. For these reasons, the higher strength rod combinations gave better bend test results.

In addition to the bend test results, it is significant to observe the tensile test results. The tensile test fractures of those weld rod combinations which showed improvement in the bend tests usually were located in the unaffected base plate. With the use of a high strength weld rod combination and excess weld metal in the face bead, the tensile properties of welded high yield strength line pipe, with the exception of the elongation, should be essentially dependent upon the strength of the base plate material. The bend test results, due to their relationship to ductility and welding technique of individual welders, are subject to greater variation in the welding of high yield strength line pipe.

A number of girth welds were examined in order to evaluate the influence of chemistry on the structure and properties of the welded pipe joint. The 26 x .312-inch wall pipe (Code A) with a chemistry of 0.37 percent carbon, 1.27 percent manganese, had root bends which withstood 180-degree bend, but several failures occurred in the face bend tests, although the average angle of bend was nearly 180 degrees. The yield and ultimate strengths of the weld tensile tests were much higher compared to ordinary Grade B line pipe material, due to the higher chemistry pipe and weld rod. The elongation was lower and the tensile tests usually fractured in the base plate, although in two instances fracture occurred in the weld.

The 18 x .312-inch wall pipe (Code B) had bend and tensile test results comparable with the 26 x .303-inch wall pipe. The higher chemistry of the 18-inch pipe was responsible for a slightly lower average angle of bend, and also, the increased yield and ultimate strength with decreased elongation. Two of the weld tensile tests fractured in the weld, while the remainder fractured in the base plate.

The type of weld bead deposited with a 5/32-inch rod and 17 inches per minute travel speed involves extremely fast cooling rates and should be used only for a comparison of various types of steel and not directly with girth weld test results.

Manganese a Factor

Although carbon usually is associated with the hardness of welds, it will be noted that manganese also is a factor. In steel containing 0.30-0.32 percent carbon an increase from 1.12 to 1.35 percent manganese resulted in an increase in maximum hardness. Similar results were obtained with steel containing 0.36-0.37 percent carbon. However, with 0.40-0.41 percent carbon material, an increase from 1.16 to 1.42 percent manganese did not change appreciably the maximum hardness obtained due to the high carbon content of the material. These results indicate that under certain conditions, it may be more desirable to increase the carbon content in preference to manganese in order to secure higher yield strength material. A closer relationship to the conditions encountered in girth welds will be obtained when results from tests being conducted with a 3/16-inch rod and nine inches travel per minute speed are available. In line pipe welding, carbon usually has been considered the most important factor with respect to the maximum hardness obtained in the weld. These results indicate that under certain conditions, manganese may be the controlling factor.

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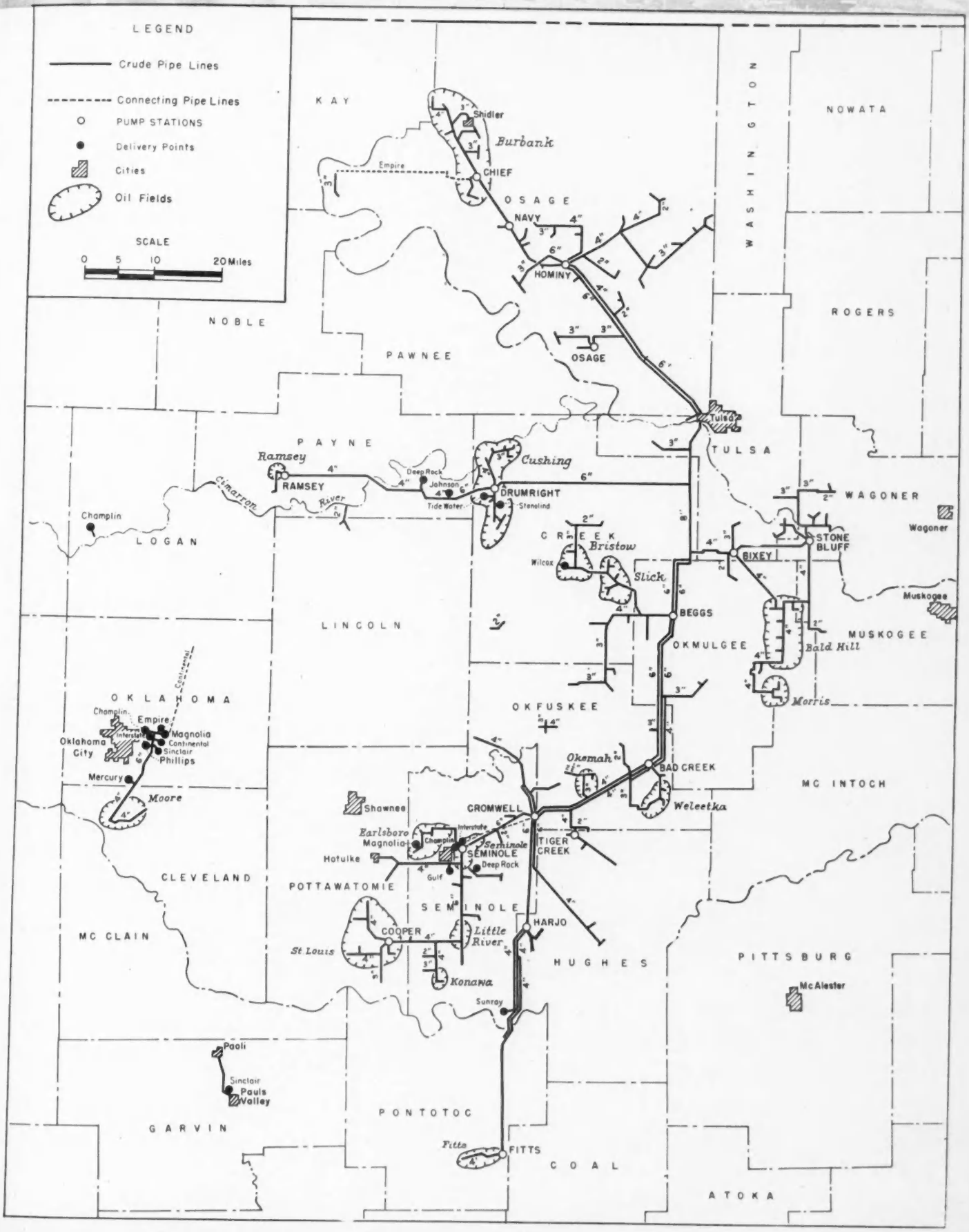

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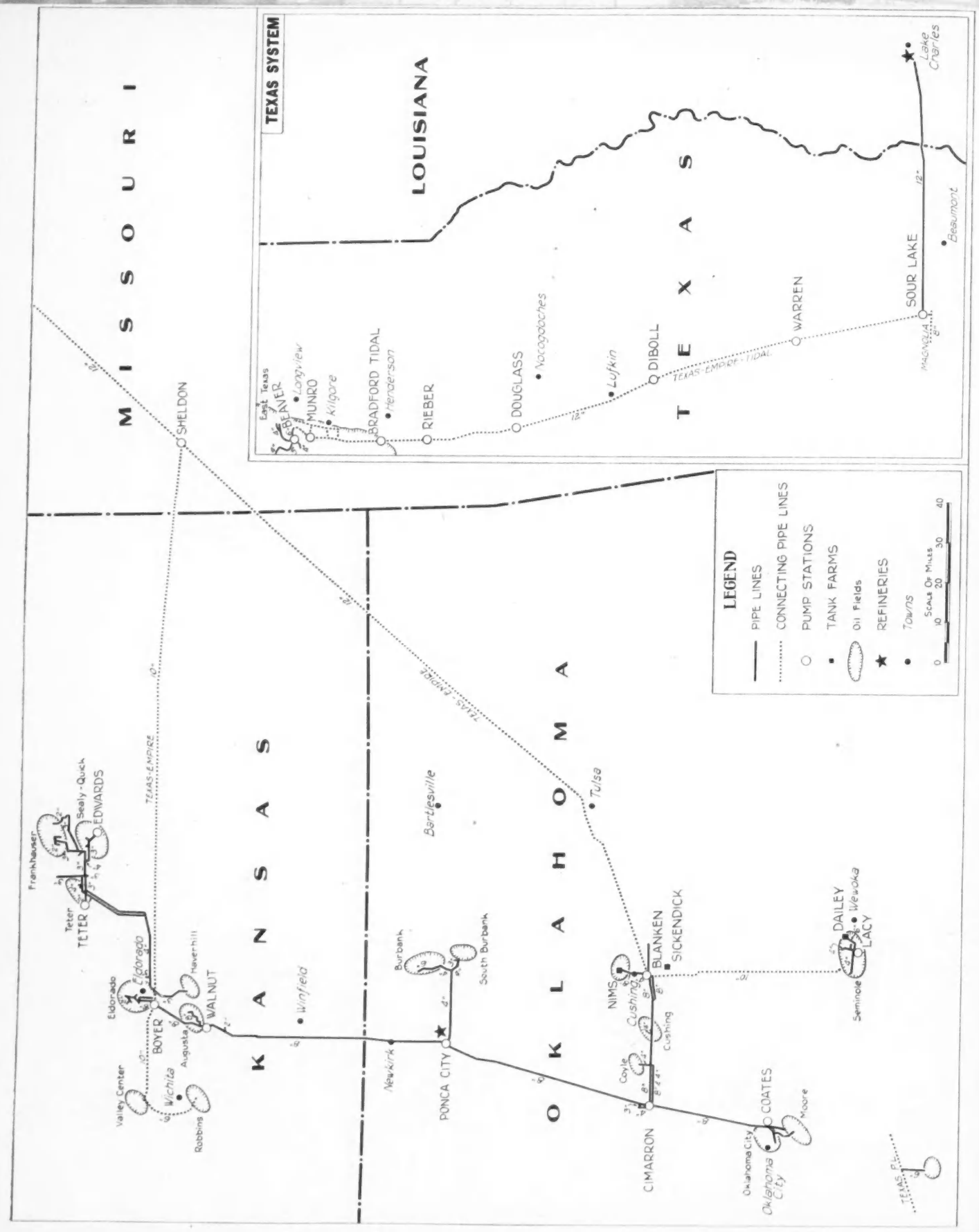
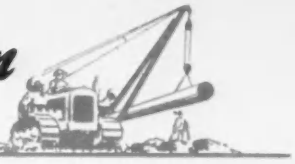


PIPE LINE *Construction*



Emphasis Placed on Gas Line Construction

ABOUT 5160 miles of pipe line construction was concerned in the reports for the past month, and gas lines formed almost two-thirds of this total.

Emphasis continued on the development of new facilities to increase natural gas systems. Total sales of natural gas showed significant increases over a comparable period in 1946 and gas was required for industry, municipality and individual use far from Texas and Oklahoma, where it was plentiful. Too, stocks of heating and fuel oils east of the Rockies and north of the Gulf Coast were less than a year ago. The longer lines now building or enlarging are chiefly gas transmission lines, but only three of these will be effective during the winter. Texas Eastern Transmission Corporation would soon apply to FPC for permission to construct a third loop to its Big and Little Inch lines, but was now engaged in making contracts for gas supplies to obtain necessary reserves. The third line is a necessary precaution, since TET is obligated to maintain the two main lines for conversion into oil transporters in case of war emergency, and a third line would prevent interruption to gas service to industries in the East while the transformation is achieved.

Tennessee Gas Transmission Company has a new application before FPC for construction and expansion totaling $150 million. This will expand its system by 450 million cubic feet daily. Construction is being carried forward on a parallel line to its original carrier which will give it a daily capacity of 600 million cubic feet.

Gas is to be flowing through El Paso Natural Gas Company's 1204-mile line from West Texas and New Mexico to California before Christmas. Dedication ceremonies were held November 13, though 90 miles remained to be laid at that time. Purging and packing of the California end of the line started early in November.

Another sizeable gas project went before FPC, as a new company, Commonwealth Natural Gas Corporation, proposed to construct a 537-mile line from a TGT connection in Kentucky to Norfolk, Va., to carry 100 million cubic feet of gas. No compressor stations were planned, the line being designed to operate on TGT pressure at the connecting point. Estimated cost of the project and related facilities is $29,522,100.

Ohio Fuel Gas Company's application to FPC to construct underground storage and extend other facilities was made on the basis that as production declined in Ohio gas fields supplies must be obtained from other sources and a substantial increase in storage facilities will be required. The compressor station and the 22-mile pipe line included in the application will not be constructed until 1948.

Completion of two crude lines was of material aid in relieving the burden on part of the systems of Humble Pipe Line Company and Sunray Oil Corporation. Humble completed a 40-mile line between Satsuma and its Baytown refinery that speeded delivery of greater quantities of crude to tidewater shipping, and took the load off the former line via Webster. It also enabled the company to salvage a substantial amount of pipe line, and reduces operating expenses by providing low pressure operation, which the old arrangement did not. Crude is being pumped through Sunray's line joining its Velma field station and the refinery at Duncan, Okla. The line will be extended to the second refinery at Allen and serve as a products exchange between the two plants.

One major problem of supplying California with crude as well as gas is not yet solved. Economic studies and plans for right-of-way for a joint line from West Texas to Wilmington refineries, announced by Shell Pipe Line Company and a number of interested companies last spring, are still being made. Meanwhile, California demand is high and its reserves depleted by its supply of the Armed Forces during the war years. It is still maintaining a military reserve and "shortening" the Middle West. The 20-inch line is tentatively planned to carry 150,000 barrels of crude per day.

Chief development in the products systems now being constructed was completion of part of Sinclair Refining Company's Texas System from Corpus Christi via Austin to Bryan. There it will be linked to the Houston-Fort Worth line now under construction, to greatly ease the flow of refined products from the Gulf Coast north to the Great Lakes areas.

Pipe Line Construction Activity

COMPANY	Origin and Terminus	Length (Miles)	Pipe Size (Inches)	Daily Capacity (Bbls., Cu. Ft.)	Remarks
CRUDE OIL LINES					
The California Co.	Rangely field, Col., to Salt Lake City, Utah	180	10	22,000	Company acquiring right of way. Construction to start Spring, 1948; complete July 1, 1948.
Col-Tex Refining Co.	Col-Tex refinery near Colorado City, to Westbrook field, West Texas.	5	6	.....	Line replaces old 3 & 4-inch carrier; construction under way.
Humble Pipe Line Co.	Satsuma station to Baytown refinery, Texas Gulf Coast.	40	20	150,000	Completed November 13, by Latex Construction Co., Houston. Relieves burden on Satsuma-Webster-Baytown line by 50 percent and replaces high pressure with low pressure operation. Increased facilities at Satsuma and Baytown involve laying of 1 mile 26-inch line and three miles 16-inch line replacing 12- and 8-inch lines. New line can handle 233,000 barrels daily in emergency.
	Loop near Gladewater on line from Hawkins field to East Texas field terminal.	5	10	.....	Increases line capacity to 55,000 barrels.

■ CONTINUED ON NEXT PAGE

Pipe Line Construction Activity

(CONTINUED)

COMPANY	Origin and Terminus	Length (Miles)	Pipe Size (Inches)	Daily Capacity (Bbls. Cu. Ft.)	Remarks
Magnolia Pipe Line Co.	Mertens station, westward loop	22 1/10	12		
	Walnut Springs station, westward loop	16 1/2	12		
	De Leon station, westward loop	30	12	15,000	Loops on 325-mile Midland Corsicana, East Texas carrier. Construction by Oklahoma Contracting Co., Dallas.
	Sweetwater station, westward loop	16 1/10	12		
	Iatan station, westward loop	13 1/5	12		
Mid-Continent Pipe Line Co.	Asher to Elmo City, Oklahoma	46	6	.....	Completion expected in early December; 35 miles laid by C. P. Carter Construction Co., contractors.
Phillips Pet. Co.	Garnett, Kans., to Buffalo, Okla.	48	8	.....	Construction started November 1 by Deaton & Sons, Odessa: to be completed December 15.
Root Pet. Co.	Ora field, La., to El Dorado, Ark., refinery	26	6	.....	Smelling Co., Shreveport, La., awarded contract.
Simrall Corp.	Reed City to Newaygo, Mich.	42	6 & 4	.....	E. J. Mahoney Contracting Co., Mt. Pleasant, Mich., started work October 3, 1947. Scheduled completion date November 25.
Stanolind Pipe Line Co.	Post field, Garza County, West Texas, to connect with 16-inch trunk line near Lubbock.	60	6	.....	Contract awarded to R. H. Fulton & Co., Lubbock.
Sunray Oil Corp.	Velma station to Duncan refinery to Allen refinery, Okla.	94	6	.....	The 17-mile line from Velma to Duncan, completed, and more than 43 miles of other line laid by Pipe Line Service Co., Seminole, Okla., contractor. Double lines between Velma and Duncan, and reversible lines between 2 refineries for exchange of products. Scheduled completion date Dec. 15.
PRODUCTS LINES					
Phillips Pet. Co. and Shamrock Oil & Gas Co.	Borger refinery, Texas Panhandle, via McKee to Denver, Col.	360	6	5,500	First spread, 307 miles from McKee to La Junta, Col., being completed by H. C. Liles Construction Co., Oklahoma City. La Junta-Denver 152-mile section to be finished in 1948, if pipe can be procured.
Sinclair Refining Co.	Houston to Arlington, (Ft. Worth) Texas	260	10	.....	Contract awarded to H. C. Price Co., Bartlesville, Okla., and work started November 15. Part of products system now being linked from Corpus Christ to Bryan, and Houston via Bryan to Ft. Worth. Corpus line completed; also Austin to Bryan; deliveries scheduled for November 15. San Antonio spur expected to complete in November. O. C. Whitaker Co., Ft. Worth, contractors on this line.
	Corpus Christi to Austin, South Texas	190	8	.....	
	Austin to Bryan	82	6	.....	
	Spur from Corpus-Austin line, near Luling, to San Antonio	53	6	.....	
Tropical Oil Co.	Barrancabermeja to Pto. Berrio, Antioquia, Colombia	125	6	7,200	Scheduled to complete in December; 100 miles already laid. Will take products to Berrio when Magdalena River is too low for shipping.
Antioquia (Colombia) Railroad	Pto Berrio to Medellin, Colombia	107	6	.....	Continuance of above line, to take refined products and crude to westward industrial town. Company is owned by district government.
NATURAL GAS LINES					
Arkansas-Louisiana Gas Co.	Ada gas field, Webster Parish, 4 mi se Dubberly, to connect with trunk line to north, Louisiana	9	10	18 mln	Field has been shut in for lack of outlet since 1944 discovery.
Cheyenne Light, Fuel & Power Co.	Near Cheyenne, Wyo.	11	16	5 mln	This is portion of what was to be Denver-Cheyenne gas line; to be used for storage, while project is delayed for lack of pipe.
Chicago District Pipe Line Co.	Joliet to Chicago Ill.	19	24	.....	Construction completed by Midwestern Constructors November 1.
Cities Service Gas Co.	Drumright to Little, Okla.	52	16	.....	This is part of Cities Service's modernisation program to replace little used lines in the system. Deaton & Sons, Odessa, took up and racked the line. Project completed October 25.
Commonwealth Natural Gas Corp.	From TGT trunk line at West Bend, Ky., to Norfolk, Va. Laterals to Roanoke, Petersburg, Richmond, and Suffolk, Va.	537	20	100 mln	Application filed with FPC.
Continental Oil Co.	Tepetate field to alkali plant at Lake Charles, La.	50	14	.....	Contract awarded to Eastern Construction Co.
CZPPP (Central Governing Body of the Industry of Liquid Fuels)	Debowiec gas field, Silesia, to Cieszyn, Poland	9 1/5	.....	.....	Line to be completed in 1947.
Lloydminster Gas Co.	From Lloydminster field to town, Saskatchewan, Canada	6	6	.....	Completed at cost of $50,000; supplied by 5 wells in field.
Mid-Continent Gas Transmission Co.	Liberal, Kans., via Kansas City to St. Paul, Minn.	836	26	.....	Second application before FPC postponed until November 25.
Northern Natural Gas Co.	Nebraska loops from South Sioux City to Fremont	50	18	.....	Eastern Construction Co.'s two spreads started work October 28.
Ohio Fuel Gas Co.	Compressor station at Monroe, Richland County, Ohio.	.....	.....	.....	Will serve as repressuring station for Perrysville storage area. Both station and 22-mile line included in application made to FPC to increase storage capacity.
	From Brown compressor station to Pavonia station, Ohio.	22	16	.....	
Tennessee Gas Transmission Co.	Looping of main line from point near Corpus Christi to Station 14 at Burnaugh, Ky.	770	30		Application before FPC. New construction and amplification of system to cost $150,000,000. Application further includes 5 compressor stations with total of 50,000 HP and additional compressor unit totaling 125,200 HP; also various laterals and facilities in Southwest Texas to tap new gas supplies. Volume of gas to increase from 600,000,000 to 1,055,000,000.
		124	26		
	Extension from Burnaugh to point near Boston, Mass.	170	26		
		480	24	455 mln	
		140	20		
	Spur from point on line in eastern Ohio to Pittsburgh	65	16		
United Gas Pipe Line Co.	Barataria to New Orleans, La.	18	10		Project expected to be completed early November by the B. & M. Construction Co., Oklahoma City.
		23	12	.....	
Wisconsin South Gas Co.	Connection with Natural Gas Pipeline Co. of America, Kenosha, Racine, and Walworth Counties, Wisc.	5	6	.....	FPC hearing on application set for November 19. Acquisition and construction of lines to cost estimated $342,000.

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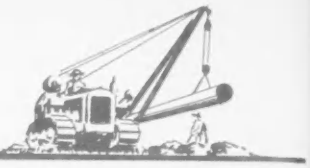
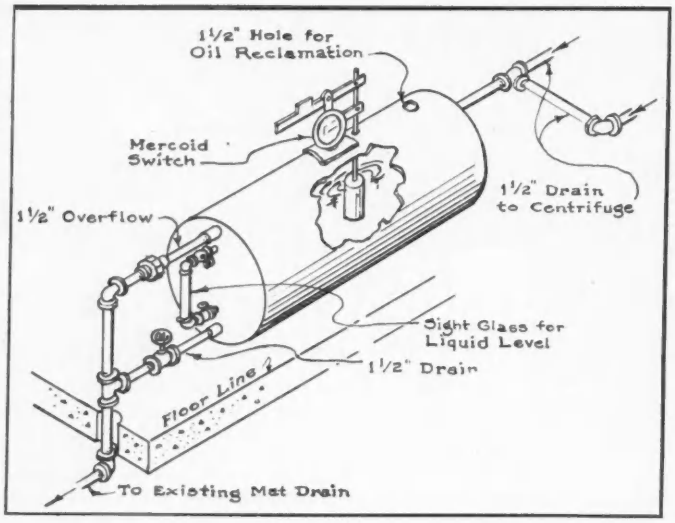
PIPE LINE HINTS



$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas

How To—Recover Oil from Centrifuge when Water Seal is Broken



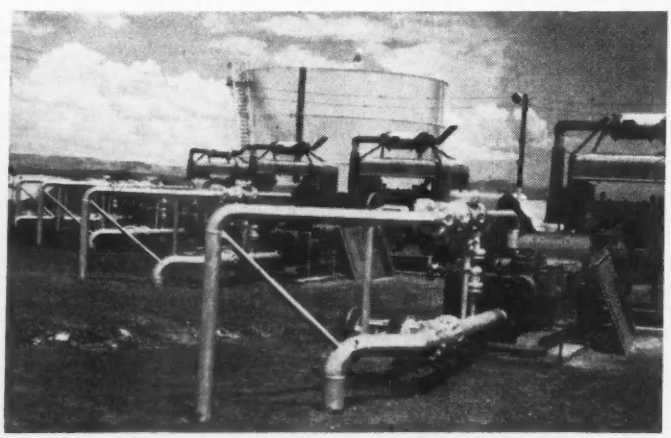
A sump or catch tank has been installed at one pipe line station in connection with a new centrifuge to catch the discharge oil in case it should break the water seal. When the water seal is broken or if any mechanical failure should occur which would throw oil out the dirty side or drain side of the centrifuge, oil will be collected in the tank. With a capacity of approximately 50 gallons, the tank is made from 16-inch O.D. casing and is fitted with a float and mercury switch which controls the centrifuge motor and heaters. The switch functions when the tank fills approximately three-fourths full, or about 35 gallons which is about 8¼ inches of oil from one side of the settling tank on the engine. This volume of oil is a safe margin because the centrifuge will never be operated on a running engine with less than 8½ inches of oil over the engine suction line. This is only about 12 or 13 inches of oil in the clean or suction side of the engine.

The tank was made large so that as much oil as possible could be saved in the event of a serious water leak on the engine, in which case the station crew would have sufficient time to drain the tank and keep the engine in operation until it could be shut down and repaired.

The unsightly mess of a continual drain from the centrifuge is also eliminated by the tank. When it becomes filled, it can be drained and the trench washed out and cleaned.

Hose connections in the centrifuge suction have been installed as have discharge lines to be used to reclaim oil from the sump tank. Over a period of time, all the oil which is thrown from the centrifuge can be cleaned and returned to the settling tank of an engine.

How To—Support Pump Suction and Discharge to Absorb Pulsations



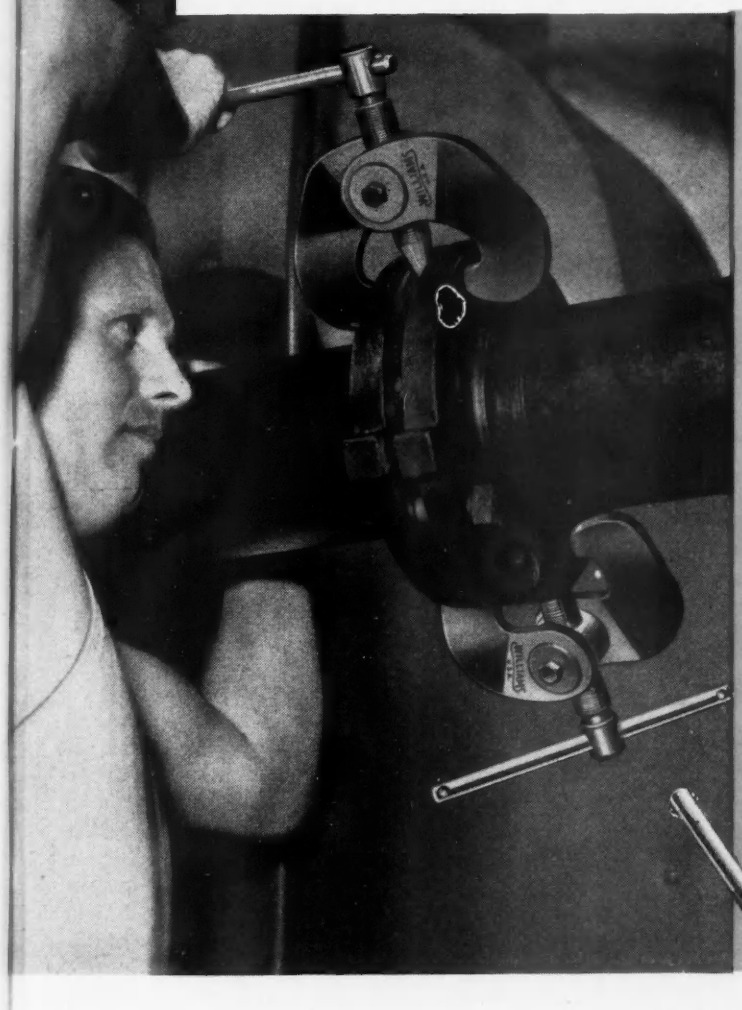
One pipe line company utilizes the suction and discharge lines at its outdoor stations to provide support for both pipes and to reduce vibration. The lower line in the view is the suction line, carried close to the ground, with a support below the surface at the elbow, and with a clear span carrying the valve and bypass connections.

The upper pipe is the discharge line, which is built with a 45-degree side bend, as is the suction. This angularity of the pipes with the pump's center line aids in absorbing pump pound and expansion changes.

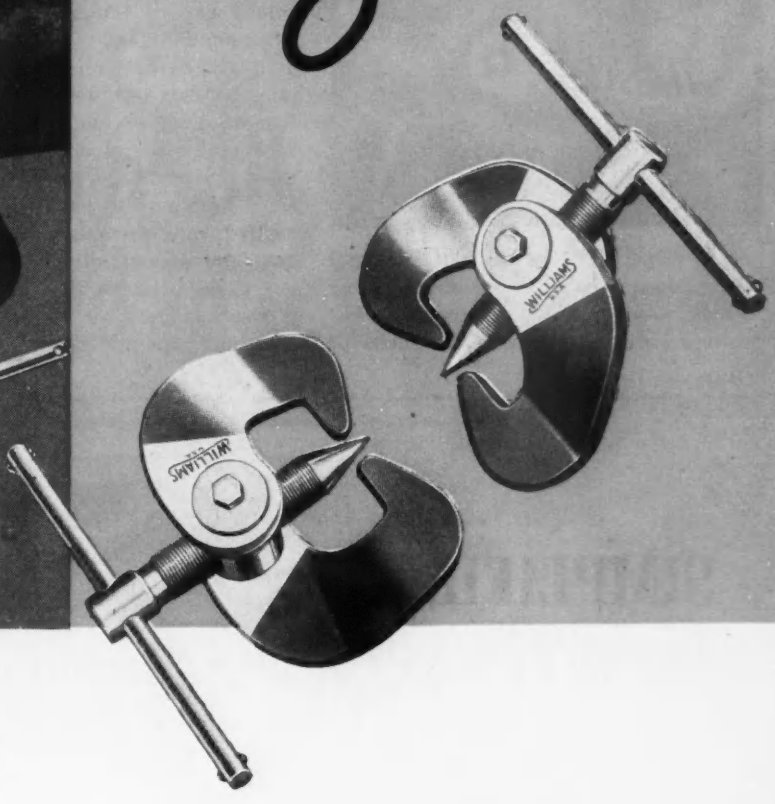
Two struts, each of 1½-inch pipe, are welded between the two pump lines, one being vertical, and set just inboard from the elbow. The other, extending from the discharge elbow to the suction fitting, is at approximately 45 degrees from the vertical, and with the other strut, forms a truss which enables each line to act as brace and anchor for the other.

The side bends in both lines are placed outside the two main control valves. This placing permits either valve to be replaced without straining the pump or the welded truss, simply by slightly twisting the flanges so as to increase the angle. Sufficient clearance is thus obtained to permit a change of ring gaskets; re-alignment being obtained when the flange bolts are pulled tight again.

Gasket Replacement made easier



-with Flange-Jacks



THESE fully-patented WILLIAMS' FLANGE-JACKS take the guesswork out of gasket replacement. Operating with a minimum of effort, FLANGE-JACKS exert tremendous pressure smoothly and evenly. The flanges are parted quickly and held in perfect alignment without damage to flange faces.

There is no shock along the pipe line, no danger from flying wedges and no sparks are caused by hammer blows. FLANGE-JACKS eliminate costly shut-downs, making possible fast, economical repairs in hard-to-get-at locations.

Ask to see these new WILLIAMS' FLANGE-JACKS at your nearest "Oilwell" store.

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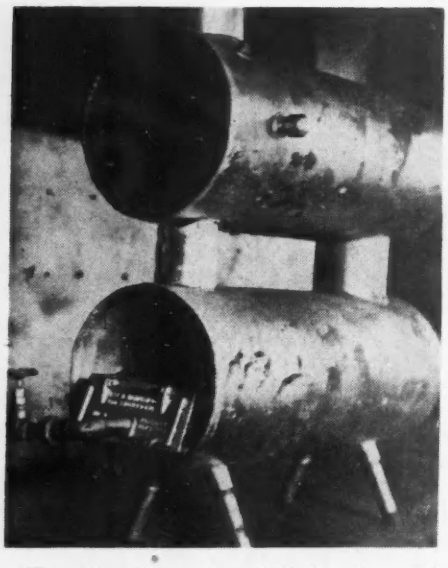
How To—Fabricate Pipe Line Warehouse Heater



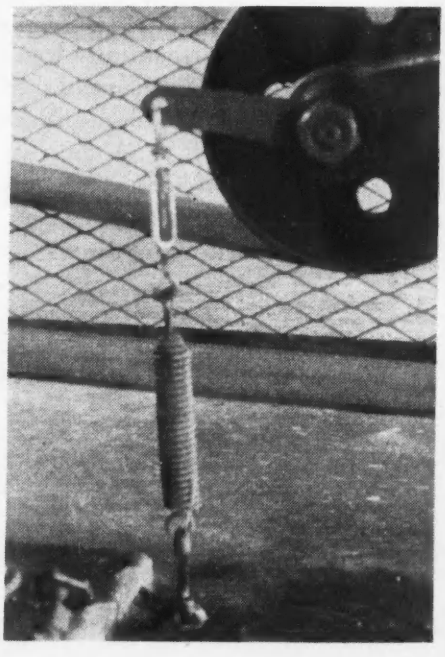
For dispelling the chill in the tool room of a pipe line warehouse, one welder fabricated an inexpensive gas burning stove from the metal shells of two discarded 20-gallon household hot water tanks, some odd bits of pipe and a few fittings. The tank shells which serve as heat radiating surfaces lie horizontally, one above the other as shown. To the bottom shell, four one-inch pipe collars were welded. Into these collars, one-inch pipe nipples six inches long were screwed, thus forming legs for the stove.

A rectangular hole was cut in the recessed end of the lower tank shell to accommodate and permit the insertion of a gas burner, together with its rectangular cast iron container with hinged flap door. A six-inch hole was cut in each tank shell at equal distances from their convex ends. Into these holes a short section of six-inch pipe was welded, thus forming a separating support and a conducting channel for the hot gases between the two tank shells. A riser, made from a notched piece of four-inch pipe and tack welded in place serves as a separating support between the two tank shells at the burner end. A six-inch hole was cut in the top side of the upper tank shell a short distance from the recessed end. Into this hole a three-inch length of six-inch pipe was welded. Over the end of this metal ring the end of the thin metal conventional stovepipe was slipped, thereby forming a conducting channel for conveying the fumes of combustion to the outer atmosphere.

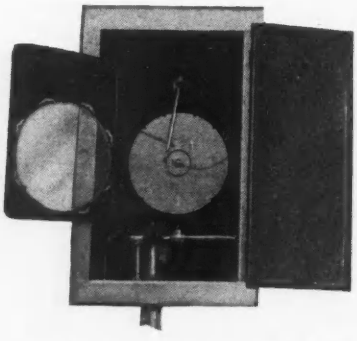
As a feature of convenience for lighting the burner, a pilot light made from a piece of quarter-inch flexible copper tubing and controlled by a stopcock tapped into the gas line ahead of the gate valve controlling the gas flow to the burner was installed, thus eliminating the necessity of reaching inside to light the burner.

How To—Maintain Adequate Belt Tension

To keep the desired tension on a belt driving a pump, a coil spring can be attached with a link to a hook set in the concrete floor. An arm of the desired length fastened to the hub of the idler pulley arm contains a hole in which a turnbuckle is placed to connect the spring with the pulley arm. Any desired adjustment can be obtained by substituting one spring for another of different wire size, or by screwing in or out on the small turnbuckle.



SIMPLIFIED MAINTENANCE



The simplicity of maintaining American METRIC Orifice Meters appeals to meter men who judge instruments in terms of adjustments and maintenance.

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How To—

Provide Additional Lift for Rear Trailer Section

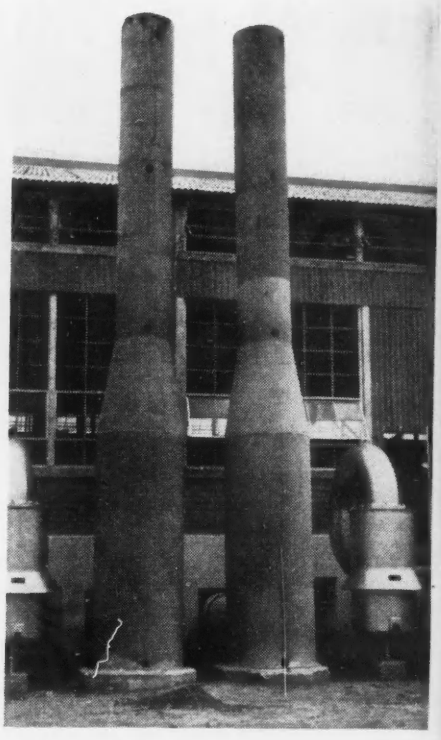
Wheels on the half trailer used by one pipe line company were found to strike the roadway causing serious tire damage when the unit was pulled up onto the power vehicle. This was due to the fact that the tongue did not lift the trailer high enough to compensate for the sag of the springs under weight of the heavy dual tires.

To give the trailer additional height when on the truck bed, a 30-inch section of light 8-inch channel iron was cut diagonally to make two wedge-shaped pieces. These were welded to the angle braces on the tongue shank on the trailer, with the sharp end forward. Between the rearward ends of the two channels, a section of extra heavy 1½-inch pipe was welded to form a cross brace between the two wedges.

When pulled up on the truck in the usual way, these wedge-shaped pieces contact the rear of the truck bed, and lift the rear wheel assembly some seven inches above the height attained when the tongue was used as bearing point.

How To—

Silence Engine Exhaust



Power wasted through the mufflers of the compressor engines in one station is utilized for two purposes by means of a housing or stack which encloses each muffler. The shell, of light steel plate, is large enough to allow a six-inch air space around the muffler body, narrowing to a stack slightly smaller than muffler diameter above the outlet pipe on the muffler unit. The stack is extended to roof height, with a square end and no baffles. At the base of the shell, again at the beginning of the smaller section, and half way from the second row to the top, two-inch holes are cut through the shell plates, four being equally spaced around the circumference.

The opening through which the exhaust pipe enters the shell is also larger than the pipe, so that the run can be jacketed with insulating material with a free air space of some four inches between pipe and cover. This latter conduit is left open in the engine room.

Flow of the exhaust through the stack draws in air through the insulating tube, and also through the holes cut through the shell. The relatively small currents of air set up at each opening break up the exhaust pulsations, so that even under full load the normally sharp "bark" of the exhaust is quieted.

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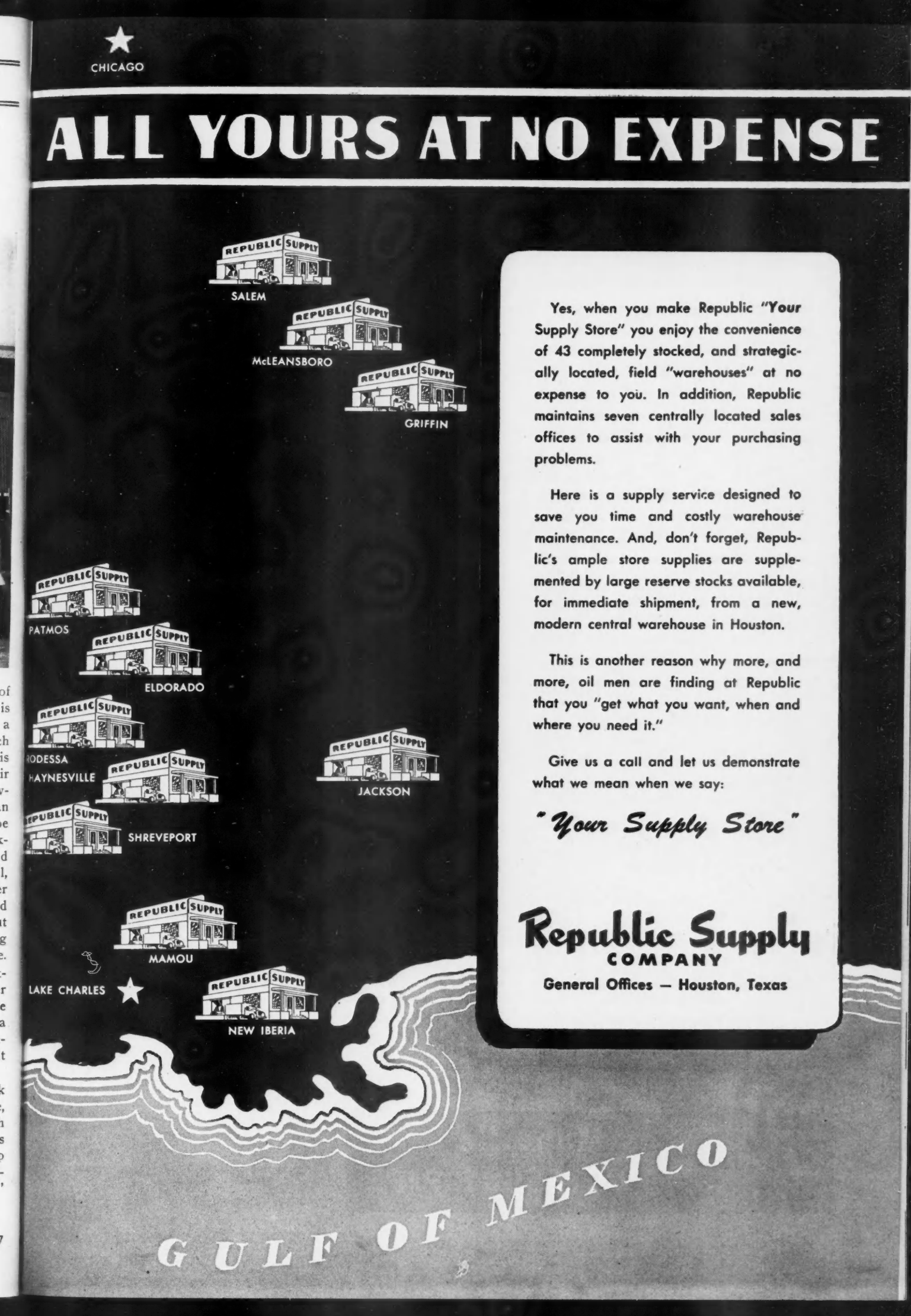
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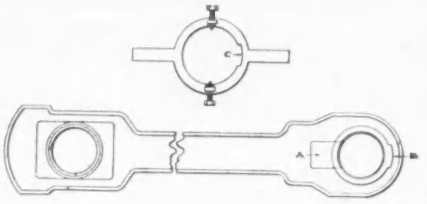
How To—Devise Spanner Clamp to Remove Bearings

Clearance conditions require a half-round seat for the bearing in the piston end of the connecting rod on horizontal compressors, and as a result the constant hammering of the explosions in the combustion chamber tends to peen the bearing solidly into the recess in the rod. At time of overhaul or reconditioning of the unit, the bearing is found so tightly set into place that it is apt to be deformed or damaged if attempts are made to drive it out with hammer and drift.



One station engineer devised a spanner clamp which could be set over the bearing half and the unit then rotated around in the recess until it became free, after which it could be slipped out through the recess without damage.

The spanner clamp consists of a heavy piece of flat stock, with a hole through it large enough to encircle the outside flange of the bearing, and with a further recess cut to engage the boss or lip at the top of the bearing half. Two set screws at the sides of the clamp are not used to force the bearing, but are turned up only enough to insure that the recess fit over the projection of the bearing and thus maintain close fit until the bearing has been loosened.

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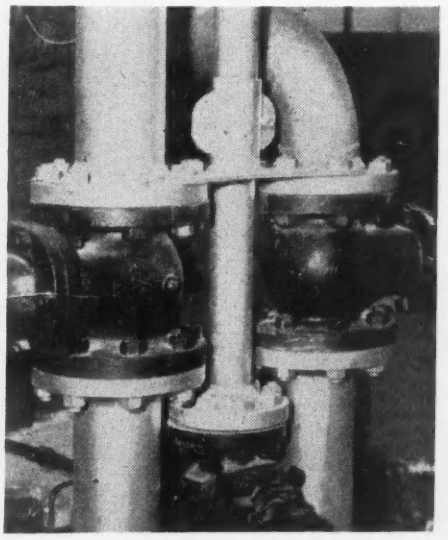
Johns-Manville TRANSITE PRESSURE PIPE

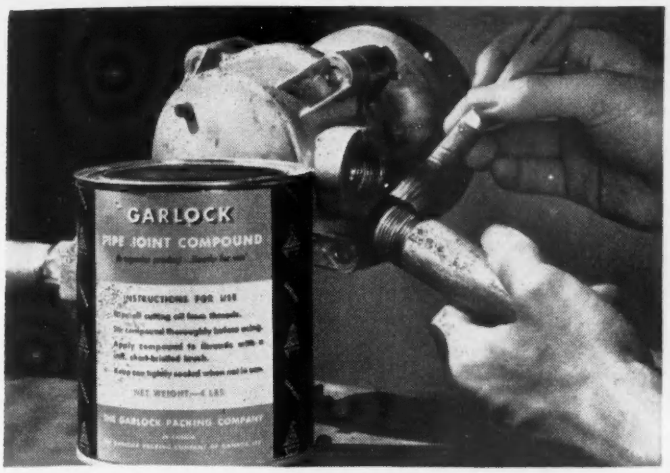
How To— Snub Pipe Vibrations



The controls on the auxiliary power engines in one station are closely grouped at one end of the engine. Outlet and inlet water mains and the gas line are set so that all control valves are operated from one position. This grouping is improved by using a tie plate to hold the lines in proper spacing, so that there is no contact through vibration of any line.

The plate is made from half-inch steel, formed to fit the bolt circles on the flanges of the two four-inch water lines. Holes are drilled to fit two adjacent bolts on each flange, and extra long bolts used at these sites to provide full threads.

To support the gas line, a collar of



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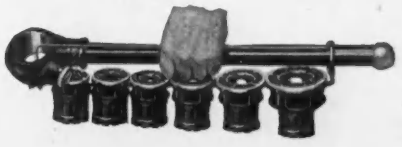

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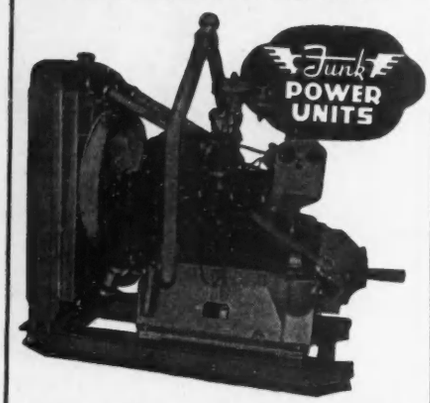

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Heavy cleanout plates on dehydration units on natural gas lines are frequently located where their removal is difficult, and as a consequence stud threads are sometimes damaged either in removing or replacing the cover.

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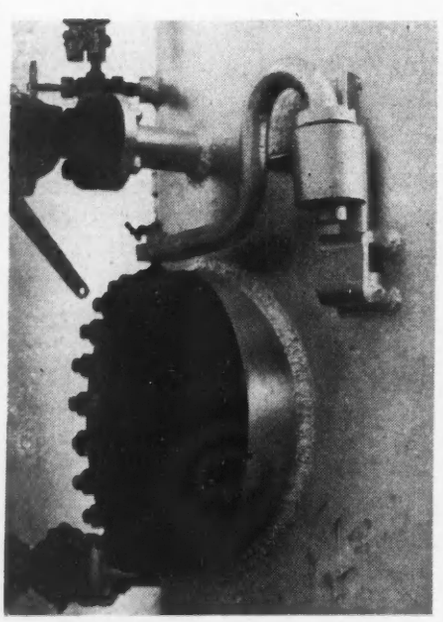
An adjustment is provided on the swivelled hanger which takes the weight of the cover, so that it can be accurately set to bring the studs in the center of the holes drilled through the cover plate.



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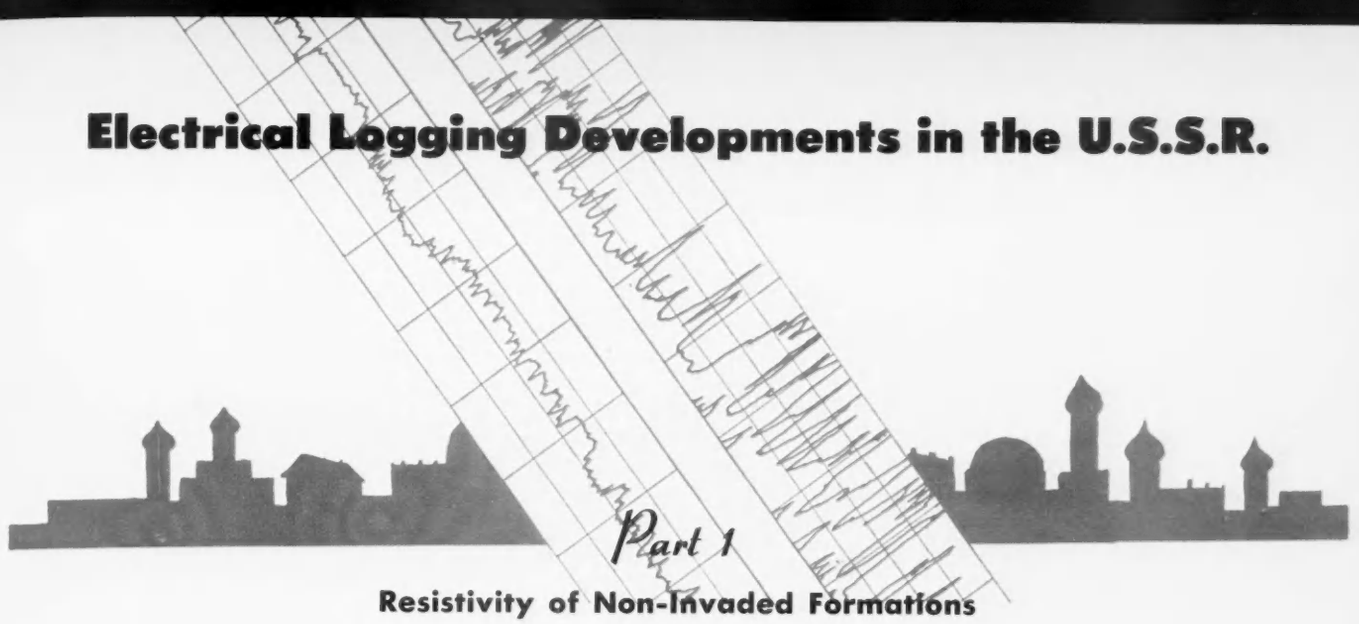
Electrical Logging Developments in the U.S.S.R.



Part 1

Resistivity of Non-Invaded Formations

By HUBERT GUYOD
Well-Logging Consultant, Houston

ELECTRICAL logging was introduced in 1929 into the U.S.S.R. Immediately the Russian technicians realized the importance of this development and started extensive field and laboratory work to ascertain the full possibilities and limitations of the new method.

As early as 1932 they reported some of their work on resistivity mapping of petroleum reservoirs and the relation between resistivity and production.[1] Unfortunately, little was heard after that date on the progress made in electrical logging in the U.S.S.R. Nevertheless, a few articles found in the available literature show that the Russians investigated extensively the potential[2, 3] and resistivity[4, 5, 6] data obtained in bore holes. Many other subsequent valuable contributions escaped notice in this country, probably because of the war. One of these contributions deserves particular attention: it is a book, prepared by Dr. V. N. Dakhnov[7], which assembles most of the results of the research, laboratory, and field work done on electrical logging in Russia up to 1939. This book, which comprises about 500 pages, discusses the following topics.

Factors controlling rock resistivity.
Use of departure charts.
Potential in bore holes.
Induced polarization.
Temperature logging.
Mechanical logging.
Application of composite logs.
Typical electric logs.
Use of electric logs for correlations.
Use of electric logs for geological mapping.
Use of electric logs for production problems.
Use of electric logs for regional geological work.

Another important book on electrical logging printed in 1938, but released a few years later, is a treatment by Dr. L. M. Alpin[8] of the theory of electrical logging and more particularly the calculation and application of departure resistivity charts. Some of Dr. Alpin's work, as well as contributions from other authors (S. G. Komarov, in particular) are embodied in Dr. Dakhnov's book.

Although the data assembled in these two books are about eight years old, they surpass everything released—and probably done—on resistivity logging in this country as of today.

No information is available to the writer on the work done in Russia after 1940 but it is likely that, notwithstanding the war, valuable investigations have been conducted during the last seevn years and of which we are not aware.

In this article and the following ones, we will present excerpts from the books of Dr. Dakhnov and Dr. Alpin, together with some of our own comments. Although many of these comments are not explicitely found in the two books mentioned above, it would be extremely surprising if they are not matters of facts to the authors. These excerpts undoubtedly will show how much we have been lagging behind our Russian colleagues in electrical logging, and it is hoped that they will be an incentive to arrange for extensive research programs on the subject during the years to come.

Departure Charts

Figures 1 and 2 give departure resistivity charts for very thick beds which are not invaded by the drilling mud. Figure 1 is for two-electrode arrangements, and Figure 2 is for three-electrode arrangements. These charts give curves representing the quantity R_a/R_m (ratio of apparent resistivity to mud resistivity) as a function of Sp/d (ratio of electrode spacing to hole diameter) for various values of R/R_m (ratio of true resistivity to mud resistivity).

The departure charts permit determina-

PETROLEUM ENGINEERS are using more and more electrical logs for investigating reservoir characteristics. In the past few years *The Oil Weekly* (now WORLD OIL) published two series of articles by Hubert Guyod on electrical well logging giving relatively elementary data for log interpretation. WORLD OIL is now presenting a new series on the subject, inspired mostly from Russian developments. This new series is a logical sequence to the others.

Hubert Guyod

tion of the true resistivity of a thick uniform bed when a number of data are available. To understand fully how to secure reliable resistivity data from these charts it is necessary to remember that the latter express a relation between the five following quantities:

True formation resistivity.
Apparent formation resistivity,
Mud resistivity.
Hole diameter.
Electrode spacing.

Any one of these quantities can be determined from a departure chart when the four other quantities are known. The electrode spacings used in electrical logging are always known accurately: therefore, the last factor need not be explicitly considered in the present discussion. There remains then only four quantities and it is obvious from elementary algebra that, if any one of these quantities has to be determined, it is necessary to secure four independent relations involving these four quantities.

In most logging problems we are interested in determining the approximate petroleum saturation of reservoirs. This necessitates knowing, among other factors, the true resistivity R of said reservoirs. The work of the Russian investigators is concentrated on this difficult problem.

To solve the problem, one relation already is available: the departure chart corresponding to the electrode arrangement used. Inasmuch as no other relation can be established a priori between the quantities involved, it is necessary to secure substitutes instead. The simplest substitutes are physical measurements, for example the measurement of:

Mud resistivity (at temperature of bed concerned).
Hole diameter.
Apparent formation resistivity with an adequate spacing.

An accurate determination of the true resistivity R of a formation will be possible when the three foregoing quantities are either known or measured accurately. If the mud resistivity measurement is reliable (representative sample data corrected for formation temperature) and if the hole diameter is accurately determined (from a caliper log, or from bit size if it is known that there is not appreciable caving or mud cake), then a single resistivity measurement will suffice to solve the problem.

It is important to note that it is not imperative to secure mud resistivity and/or hole diameter data to solve the problem concerned. One or both of these quantities can be replaced, for example, by one or two additional resistivity measurements, respectively. In other words, a departure chart permits determining the true resistivity R of a thick uniform formation when either one of the following sets of measurements is available:

1. Mud resistivity;
   Hole diameter;
   One apparent resistivity measurement near the center of the bed.
2. Mud resistivity;
   Two apparent resistivity measurements with different spacings.
3. Hole diameter;
   Two apparent resistivity measurements with different spacings.
4. Three apparent resistivity measurements with different spacings.

This possible choice, combined with the fact that almost any resistivity readings are satisfactory, shows the great flexibility of the method.

Use of one resistivity measurement: If resistivity measurements made with only one electrode spacing are available, it is necessary to measure or determine as accurately as possible the mud resistivity R_m and the hole diameter d of the formation concerned in order to solve the problem.

Let R_a denote the apparent resistivity measured near the center of the formation. If the formation is perfectly uniform, only one resistivity reading actually is necessary. In practice, non-uniformity is the rule rather than the exception, and it is therefore necessary to use for R_a the average apparent resistivity value given by the resistivity graph in the middle section of the bed.

The quantities R_a/R_m and Sp/d are calculated, Sp denoting the electrode spacing. These two numbers are the coordinates of

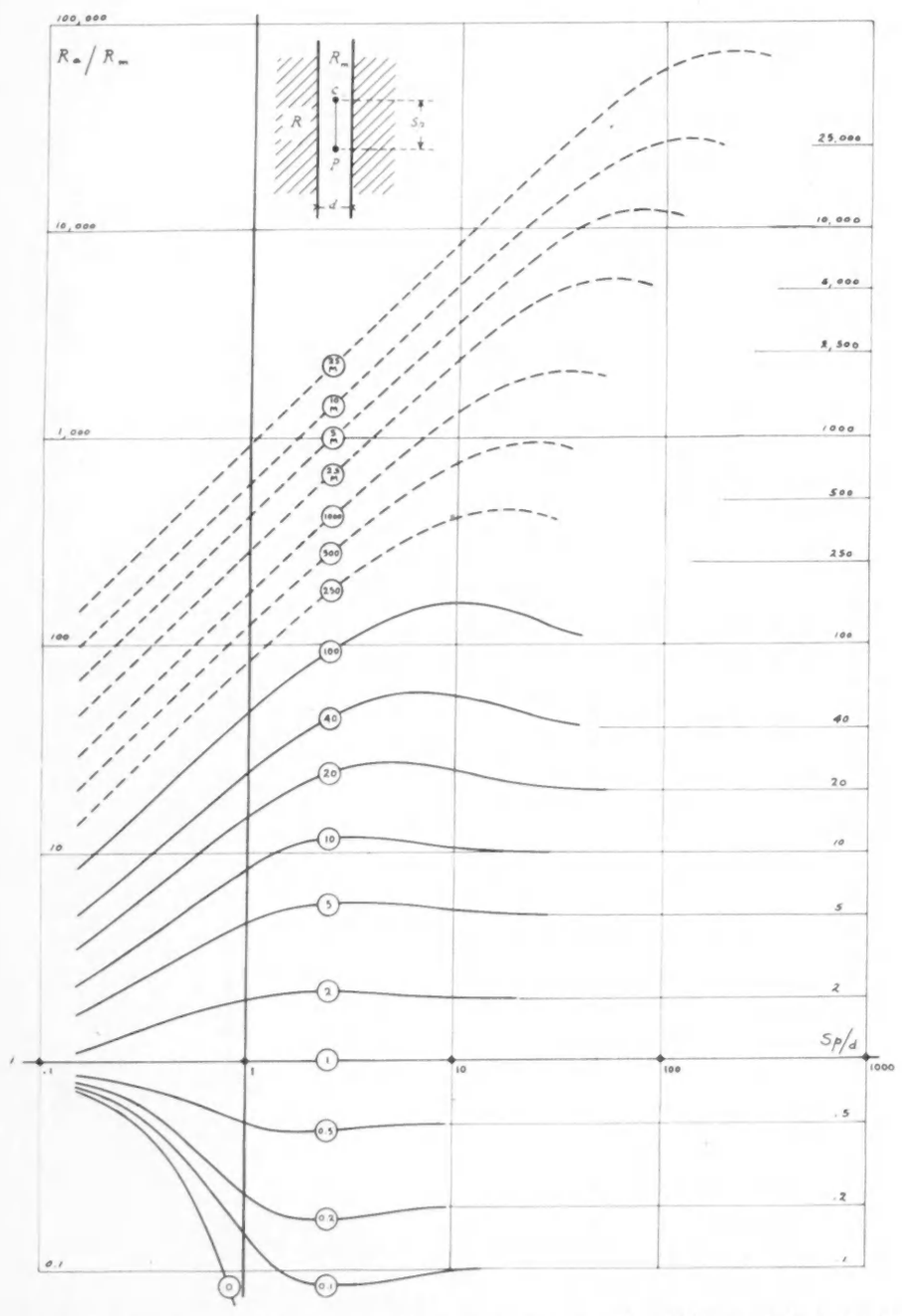


FIGURE 1. Departure resistivity chart for thick beds non-invaded by drilling mud (calculated). Figures in circles indicate resistivity contrast R/R_m. Dash line curves are extrapolated. Data are for two-electrode arrangements. (From L. M. Alpin, 1938, and V. N. Dakhnov, 1941.)

a point of the departure chart. The departure curve passing through this point gives the resistivity contrast R/R_m, from which the true formation resistivity R is determined.

Use of two resistivity measurements: If two resistivity graphs made with different electrode spacings, but with the same type of electrode arrangement, are available, either the mud resistivity or the hole diameter must be known. Suppose that the latter was determined accurately, but that no reliable value of the former is available. The quantities R_a and Sp/d corresponding to the first resistivity measurement, and R'_a and Sp'/d corresponding to the second measurement, are the coordinates of two points which are plotted on a transparent paper on which the log-log grid of the departure chart has been traced. The ordinate axis of the two grids are made to coincide and the transparent paper is moved parallel to these axes until the two points fall simultaneously on the same departure curve. Then, the ordinates R_a/R_m and R'_a/R_m of the two points, as well as the resistivity contrast R/R_m of the matched curve, are read off the departure charts. From these quantities the true formation resistivity R can be determined, as well, incidentally, as the mud resistivity.

If the hole diameter is unknown but the mud resistivity was accurately determined, a similar procedure is used to determine R. In this case, the abscissa axis of the grids are superimposed and the transparent paper is moved parallel to these axes until the points of coordinates

	R_a/R_m	Sp
and	R'_a/R_m	Sp'

fall simultaneously on the same departure curve. The formation resistivity and the hole diameter are then determined as in the previous example.

Use of three resistivity measurements. If there are no reliable data on the mud resistivity nor on the hole diameter, then the true formation resistivity can be determined only if resistivity measurements made with three different spacings are available. The electrode arrangements used for this purpose must be of the same type, otherwise the problem cannot be solved simply.

The true bed resistivity is determined by plotting the three points

R_a	Sp
R'_a	Sp'
R''_a	Sp''

on a transparent log-log grid, and moving the grid parallel to the coordinate axes until the three points fall simultaneously on the same departure curve. From the resistivity contrast of the matched curve and from the point coordinates read off the chart, it is possible to determine R, as well as the mud resistivity and the hole diameter.

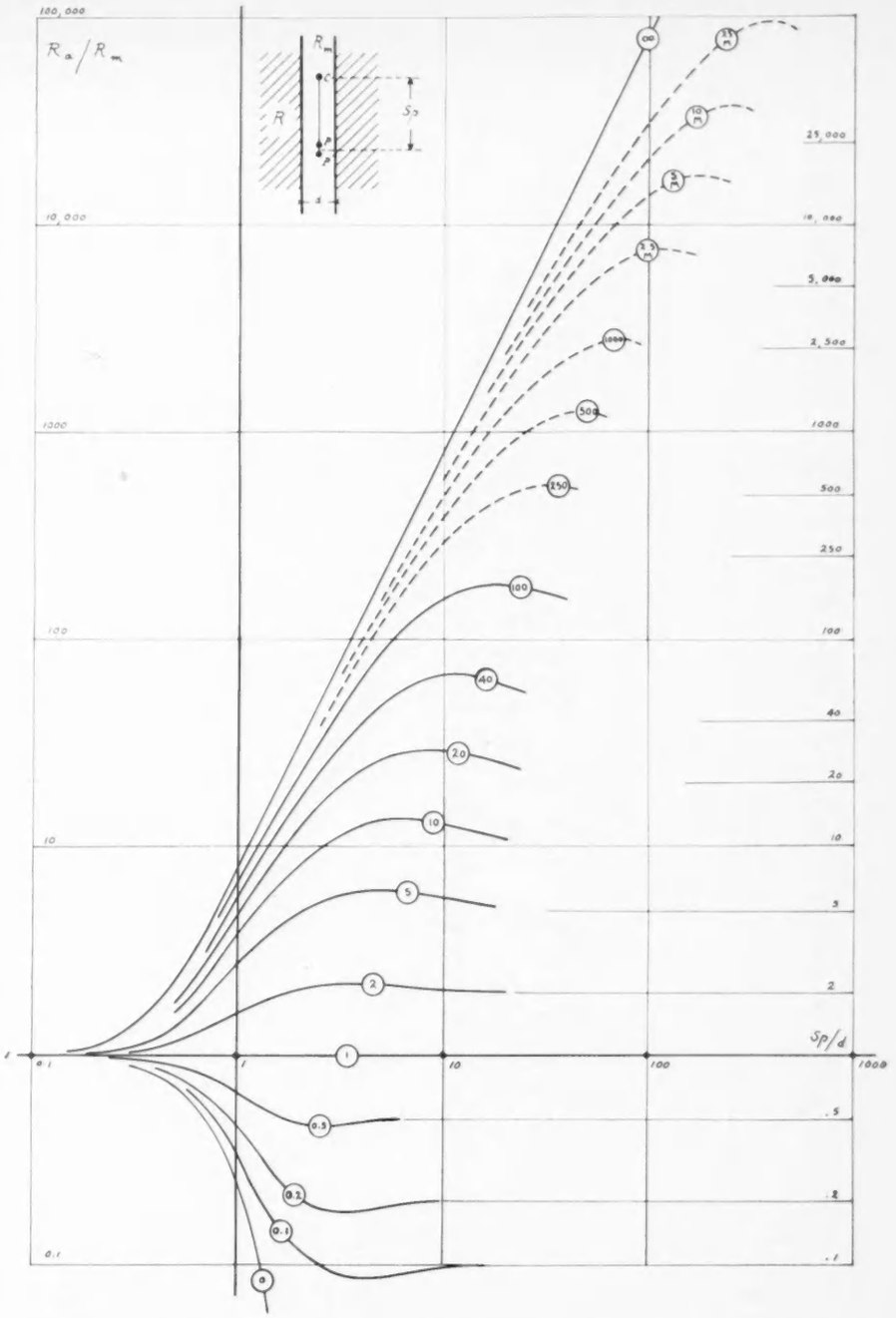


FIGURE 2. Departure resistivity chart for thick beds non-invaded by drilling mud (calculated). Figures in circles indicate resistivity contrast R/R_m. Dash line curves are interpolated. Data are for three-electrode arrangements. (From L. M. Alpin, 1938, and V. N. Dakhnov, 1941.)

Value of Departure Charts

An examination of the departure charts shows that R/R_m equals R_a/R_m, and therefore that the true resistivity is equal to the apparent resistivity, if an electrode spacing sufficiently long is used. It may then seem that no departure curve is needed to determine the true resistivity of a formation. This is correct in the case of extremely thick beds. However, in thinner beds, the same long spacings do not give true data, as can be seen from Figure 3, which illustrates the case of a thin bed B_2, a sand for example, situated in a uniform medium B_1, such as a very thick shale.

It is true that this figure shows that the true resistivity of B_2 is obtained asymptotically for extremely long spacings. Unfortunately, such spacings usually cannot be used in practice for two reasons. First, the potential difference between pickup electrodes P and P' is usually so small when such long spacings are used that it cannot be measured accurately. Second, with such spacings the current electrode C is no longer situated in bed B_2. It enters into formation B_1 with the result that current distortion, and therefore unreliable apparent resistivity data, is obtained if B_1 is not uniform, which is frequent. Because of these shortcomings it is necessary in the majority of the cases to measure resistivities only with electrode

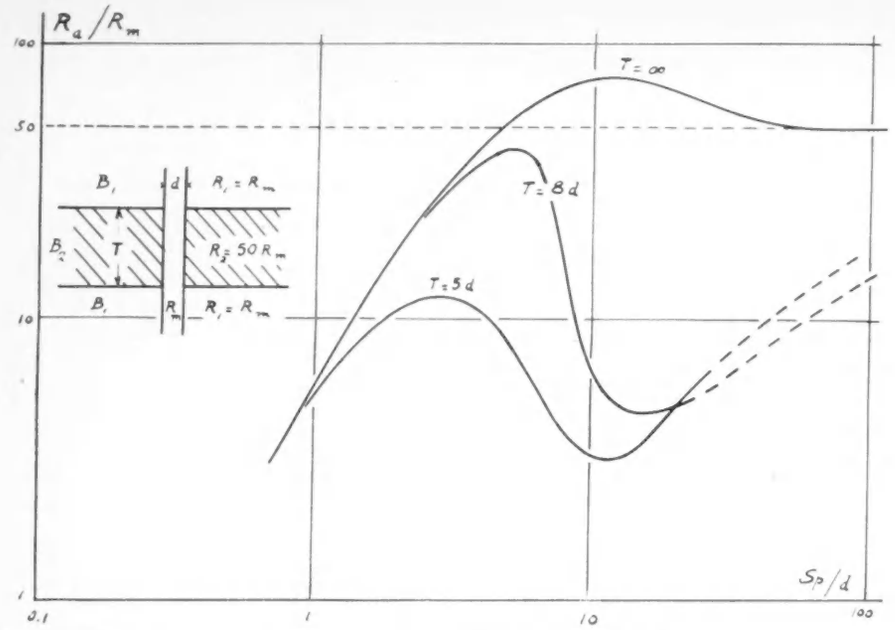


FIGURE 3. Departure resistivity curves for beds of finite thickness 50 times as resistant as surrounding medium. (Scale model experiment with three-electrode arrangement.) Data from V. N. Dakhnov, 1941.

spacings of moderate lengths and to use departure charts to determine true resistivities therefrom. Inasmuch as these charts are available and it is a simple matter to use them, there is no justification in attempting to use extremely long spacings unless absolutely necessary because of other requirements.

Thin Beds

Three-electrode arrangements: Figure 3 represents departure curves for a bed B_2 fifty times as resistant as the surrounding formation B_1, and for three different thicknesses. The mud resistivity is assumed to be equal to the resistivity of formation B_1, which is frequently the case in practice. The data are for three-electrode arrangements.

It can be seen that in the case of the two beds of finite thickness an appreciable error will be made by using the departure chart established for extremely thick formations, unless the spacings used are less than about one-third the thickness of the bed concerned. If the resistivity contrast R/R_m is much greater than 50, still shorter spacings should be used, while somewhat greater spacings may be used if the resistivity contrast is appreciably less than 50.

Figure 3 shows also that for beds of finite thickness the departure curves reach asymptotically the true resistivity for extremely long spacings, regardless of the bed thickness. However, as was pointed out before, in most instances such long spacings cannot be used.

Two-electrode arrangements: In the case of two-electrode arrangements the detrimental effect of thin beds is much greater than for three-electrode arrangements. Little data are available in the Russian literature on the subject. Nevertheless it can be stated that two-electrode arrangements can be used for resistivity determinations only in extremely thick beds, for example for those whose thickness is at least five times as great at the maximum electrode separation used.

Another shortcoming of the two-electrode arrangements is that the asymptotic value given with very long spacings never reaches the true resistivity of the bed concerned B_2: it always reaches the resistivity value of the surrounding medium B_1.

Surface Exploration Analogy

Certain phases of the foregoing discussions have been elaborated upon in more detail than may seem warranted. This was done purposely because the same principles will be used several times in subsequent articles.

It also is of interest to note that the foregoing method of interpretation is not basically new to us. It has been used extensively for many years in surface exploration and discussed in many classical papers.[9]

A frequent exploration problem, for example, is to determine the depth of a horizontal bedrock overlain by an overburden of essentially constant thickness. The problem is solved easily by making surface resistivity measurements with several electrode spacings, as shown by Figure 4. The apparent resistivity readings are plotted on a transparent grid and superimposed on pre-calculated charts, such as that of Figure 5. When a good match is obtained, it is possible to determine from the matched curve not only the bedrock depth (comparable to the bore hole diameter in electrical logging) but also the overburden resistivity (drilling mud resistivity), and the bedrock resistivity (equivalent to the bed resistivity in logging).

Determining Hole Diameter

The departure charts of Figures 1 and 2 give good resistivity data only if the mud resistivity and the hole diameter are reasonably constant in the bed concerned. Under such conditions it is found that the interpretation is unique, except perhaps in the cases of extremely high resistivity contrasts R/R_m. However, when the lack of uniformity is relatively small the method still gives good results provided average values are considered.

The departure charts can be used not only for determining true resistivities, but

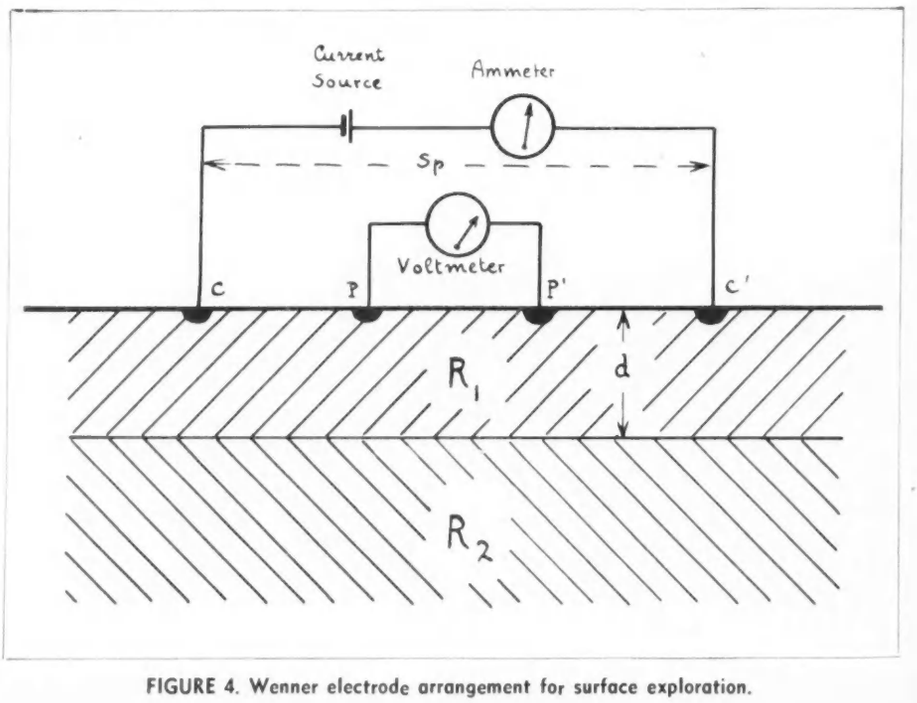


FIGURE 4. Wenner electrode arrangement for surface exploration.

also for estimating accurately the diameter of many sections of a bore hole, as was explained above. When it is remembered that primarily shales cave, while other formations usually do not, it is obvious that the method can be used advantageously to estimate the average degree of caving in many thick shale formations.

In rocksalt sections, the size of enlargements caused by dissolution cannot be determined accurately unless it is known that the mud is uniform, for example when the mud returns are saturated. Otherwise, there may be gross non-uniformities which would prevent a satisfactory application of the method.

Requirements: It is obvious from the preceding discussion that the diameter of a bore hole can be determined by this method only if either one of the following sets of measurements is available.

1. { Mud resistivity, / Two resistivity graphs.
2. { Three resistivity graphs.

It can be seen readily that best accuracy will be obtained from the first set of measurements when one of the experimental points falls in the zone of maximum slope of the departure curve, while the other point is near or beyond the hump.

When three resistivity graphs are used for the determination, one point should fall somewhat below the point of inflexion of the departure curve, the second point above it, and the last one beyond the hump.

Incidentally, it is evident that the foregoing remark applies also for resistivity determinations. The selection of adequate spacings is therefore extremely important to solve all problems involving resistivity measurements.

There are special cases when only two measurements are needed, instead of three. Consider an oil field in which the true resistivity of a shale section is known. This determination was made for example in a key well by using the procedure outlined above. If the shale resistivity remains constant in a certain area surrounding the key well, which is not an unreasonable assumption, then is it obvious that two measurements will suffice to determine the hole diameter in the shale section of other wells, for instance mud resistivity and one apparent shale resistivity.

Limitations: Figures 1 and 2 are for non-invaded formations only. Therefore, they should not be used for hole diameter determinations in permeable formations. This limitation is fortunately of little moment in most cases since caving occurs primarily in shales.

The use of departure curves permits accurate diameter determinations only if the resistivity contrast R/R_m is greater than 1.5 or less than 0.7 for three-electrode arrangements, and greater than 2 or less than 0.5 for two-electrode arrangements. This condition usually is fulfilled in most shale sections without special mud conditioning, except in certain sections of the wells of a number of Gulf Coast fields.

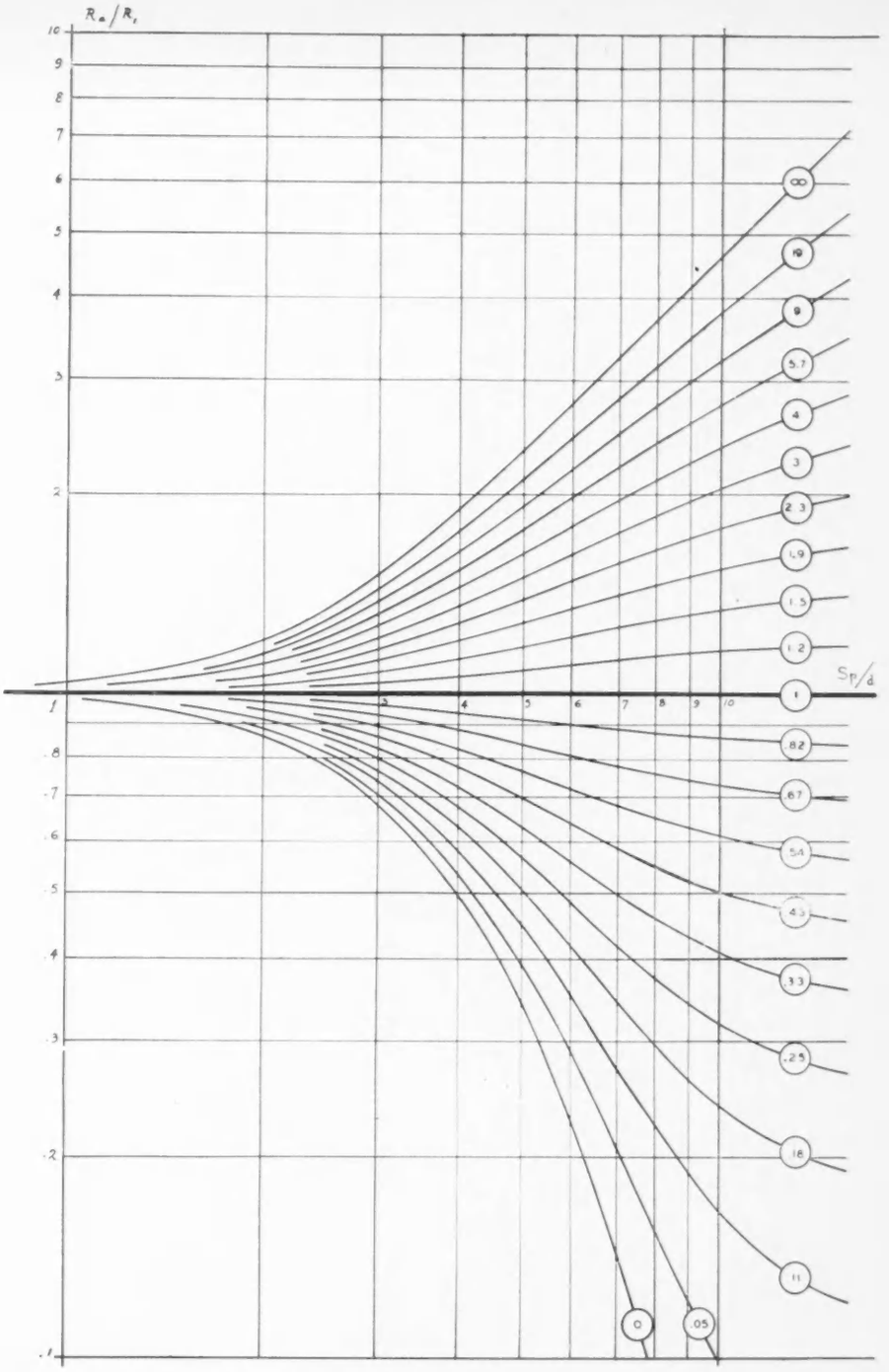


FIGURE 5. Interpretation chart for resistivity exploration with Wenner electrode arrangement (calculated). Figures in circles indicate resistivity contrast R_1/R_2. (Basic data from Irwin Roman, 1941.)

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ARGENTINA

FIVE-YEAR PLAN

ARGENTINA'S ambitious Five-Year-Plan is beginning to pay off with slightly increased production despite the enduring shortage of materials with which to carry on its ambitious exploration program.

By GEORGE O. IVES
Staff Writer

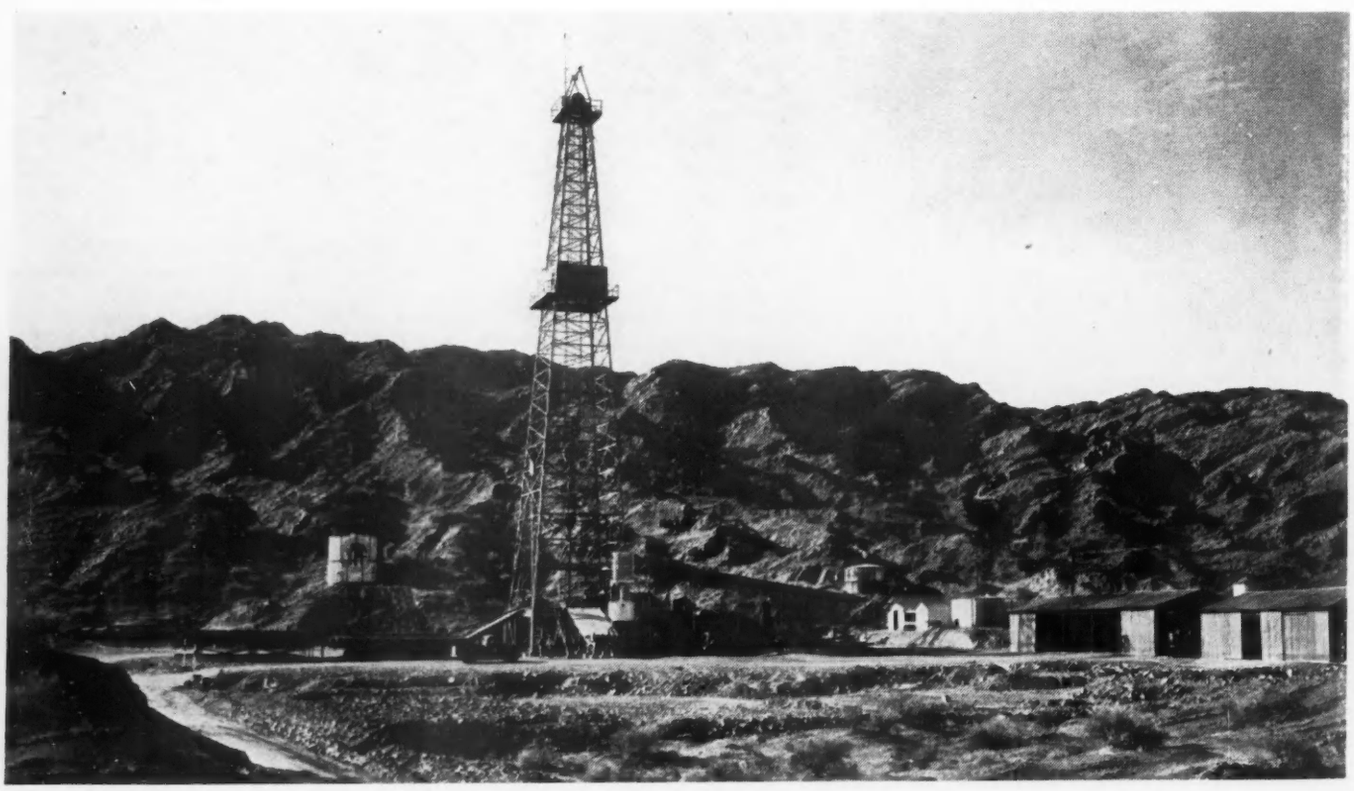
ARGENTINA, already nearing the end of its first year under Plan Quinquenal (Five-Year Plan), has yet to throw off the effects of the wartime shortage of materials, with the result that only within very recent months has its production of petroleum and products begun to compare favorably with 1946.

Declines have been steady in all settled fields during recent years, and the slight upswing of the past few months has been due entirely to production from Caleta Olivia, a field which came into production during 1946, and now yielding about 2200 barrels daily from 12 wells.

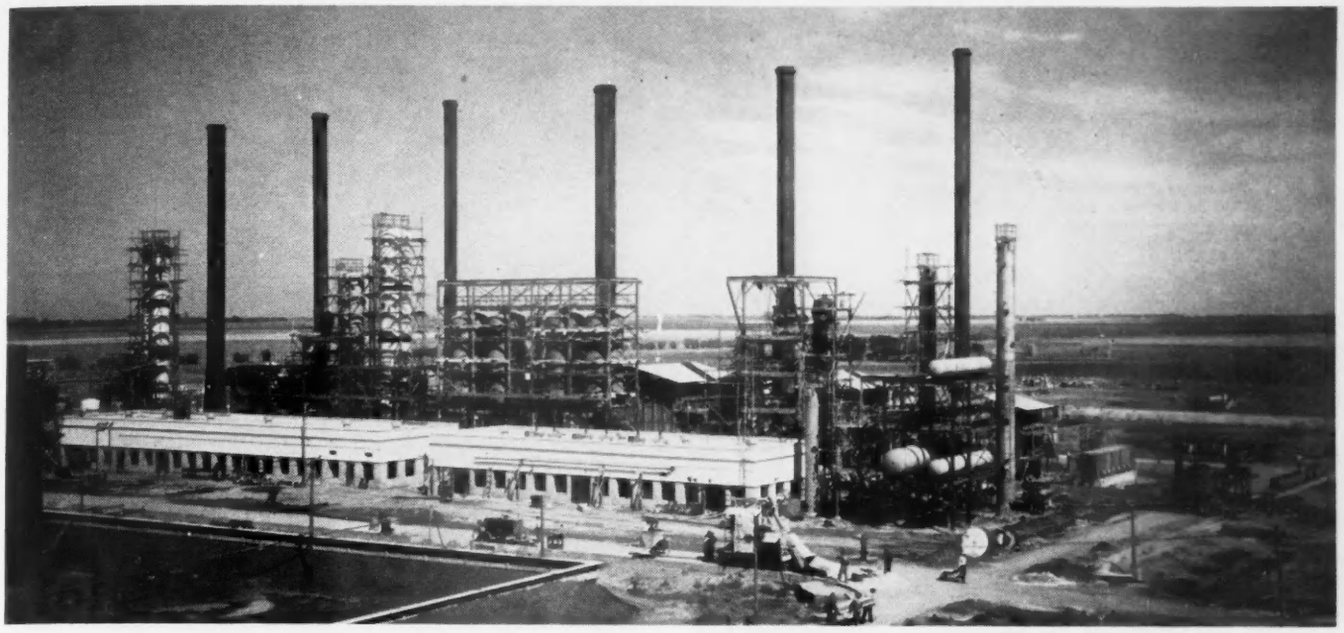
The government has assigned to Yacimientos Petroliferos Fiscales, the official government oil company, the task of increasing production from 14,212,811 barrels in 1946 to more than 22,620,000 barrels in 1951, the last year of the plan. Discounting a further decline of production, the total output for the final year would be something more than 29 million barrels.

THIS IS THE FIRST OF A SERIES OF ARTICLES BY IVES ON HIS CURRENT TOUR OF SOUTH AMERICA.

Obviously, the fields from which this added production is to come are yet to be discovered, unless Caleta Olivia alone should prove itself capable of absorbing the decline from older fields and contributing the necessary net increase. Recognizing the need for exploration, the plan calls for an elaborate geological and geophysical program designed to cover 40 percent of the country; in addition to the drilling of 314 exploratory wells. The plans call for these exploratory wells to consist of 128 structure holes and 186 full-scale wildcats. Through this it is expected to discover reserves at least equivalent to withdrawals during the five-year period.



YPF wildcat operations at Niquivil, state of San Juan.



YPF 33,000-barrel refinery at La Plata, near Buenos Aires. Scheduled for modernization under the Five-Year Plan.

YPF is making every effort to get started on its exploration program, but is plagued by a shortage of equipment. The area to be studied comprises a total of more than 148,262,000 acres. YPF has managed to put into the field only nine geophysical crews . . . three reflection seismograph, two refraction seismograph, two gravitymeter, and one magnetometer. These are working in various parts of the country now, but concentrating particularly on the southern region from Comodoro Rivadavia on down to, and including, the island of Tierra del Fuego, where reconnaissance work has shown quite favorable results. It is in this area that the most likely and earlier results are expected.

The policy of the YPF is to do all geophysical work itself. Whereas in most other countries it would be possible to contract with a number of geophysical companies for surveys, and thereby get a large number of crews into the field, it is understood that the company acquires the instruments and other equipment, and does the work with its own staff. The leaders of the exploration department are able technicians along these lines, but the company is short of a sufficient amount of both men and materials. It has been impossible to purchase the necessary equipment and consequently impossible to train the necessary personnel.

As for exploratory drilling, it has been possible to put only nine rigs to work on wildcatting. Most of these are working around producing fields, while no more than three might be considered rank wildcats. One is in the state of Salta in the extreme north, another in San Juan in the northwest, and another south of Buenos Aires. The company has acquired a number of new rigs to be used mostly for wildcatting, although some are earmarked for development at Caleta Olivia. However, these 21 rigs, acquired by IAPI (Instituto Argentino de Promoción del Intercambio) are not complete. There are 21 sets of drawworks and engines, but no pumps. Upon acquisition of the additional material this new equipment should give a substantial impetus to the drilling and exploration program. In addition, the company plans to purchase a number of other rigs for the wildcat program. Equipment now in use throughout the country with few exceptions has outlived its efficient life and is being operated only because it has not been possible to obtain replacements.

The chief stumbling block to the acquisition of materials is the lack of funds for substantial purchases. As a government agency it has to wait for appropriations to be specifically granted.

Development program through the next five years calls for the drilling of 1500 wells. In this respect it previously had been assumed that the company would do all of its own drilling, but it has been reported recently that at least two U. S. firms have been discussing large-scale drilling contracts, calling for blocks of 100 to 200 wells under each. The most difficult part of fulfilling such a drilling program is thought to be the

Scene at discovery of Comodoro Rivadavia field, 1907.

Typical of new-type service stations being constructed by YPF.

finding of 1500 locations to drill in the settled fields.

Refining Problem

With hopes of increasing its domestic production and supplementing by imports, the next concern of YPF is for sufficient refining capacity to process crude to meet its changing needs, which are expected to expand sharply with development of the industrial program.

Current refining capacity is nominally 50,000 barrels daily, most of which is concentrated in the 33,000-barrel plant at La Plata, east of Buenos Aires. The remainder is divided among four smaller plants in various parts of the country. The five-year plan calls for new buildings and a considerable amount of repair and modernization of existing plants. All the refineries are old, and it has been nearly 20 years since any work of major nature has been done on any of them.

The first major unit to be constructed will be a 44,000-barrel plant with fluid catalytic cracking, decarbonizing and metallurgical coke processes. It is to be constructed just west of Buenos Aires by W. M. Kellogg Company. The schedule calls for construction to start early in 1948, and it may be in operation during 1949. This will not increase capacity by the full amount, however, since it is planned to take off units at the La Plata refinery totaling 12,500 barrels at the time the new works are completed. By the end of 1951 YPF expects to bring its effective refinery capacity to 75,000 barrels daily, including another plant scheduled for 1951 completion at Comodoro Rivadavia. At present the company has no refinery in that area, the site of the bulk of its production.

The only new oil line planned, other than those which may be made necessary by the discovery of more fields, is a carrier from the Plaza Huincul area to Bahia Blanca, 342 miles due east. From Bahia Blanca crude would be loaded on tankers for transportation to the Buenos Aires refinery area.

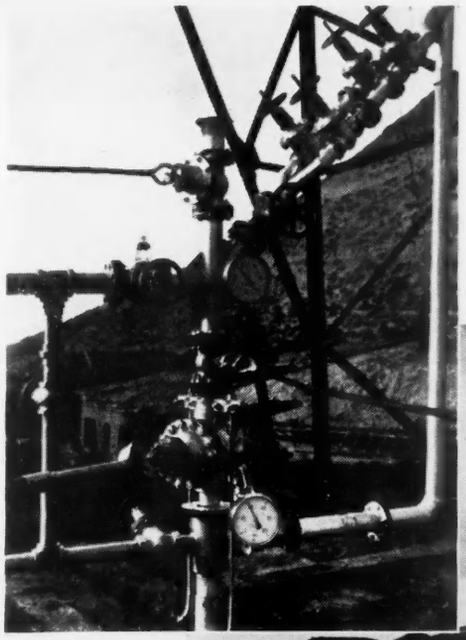
Argentina's present available tanker capacity, which now is 12,350,000 barrels carrying capacity yearly, is to be augmented by the acquisition of new units sufficient to bring the total capacity by 1951 to double that figure.

An important project already under way is a gas line to supply Buenos Aires from the Comodoro Rivadavia area. This is not under the direction of YPF, but is handled by another government agency, the Direccion General del Gas del Estado. It is an ambitious undertaking, involving the construction of slightly more than 1000 miles of line. The route has been surveyed, and construction has been started from the Buenos Aires end. The northern leg, from Buenos Aires to Bahia Blanca, is being built by the Gas del Estado itself, but contract will be let for the southern portion. A number of contractors submitted bids on the line, including one of the best-known U. S. pipe line specialists, but although no official announcement has been made, it is understood generally that the bid most acceptable to the Argentine agency was by an Italian firm of contractors. There has been speculation as to the economic soundness of the project, since the line will cost about $20 million and will transport an estimated 35 million cubic feet of gas daily.

There has been further speculation as to whether the gas reserves in the Comodoro Rivadavia area are sufficient to justify the expenditure of building the line and establishing gathering facilities at one end and distribution facilities at the other. Much of the gas in the area is under concessions held by the Compañia Ferrocarrilera de Petroleo, a private company which has plans of its own that make it doubtful if any of its gas could be made available for transportation. However, a comparatively recent development of gas is now under way just off the south edge of YPF's central field, and this is expected to furnish an additional supply. At the present time it is more or less in the process of definition, and no good idea of its capabilities can be obtained without further development. Meanwhile, gas conservation methods are being practiced in the field through gathering and cycling all of the gas produced with oil, and the entire area is in remarkably good condition considering that it is not a multiple-sand development, and that it has been producing continuously for 40 years.

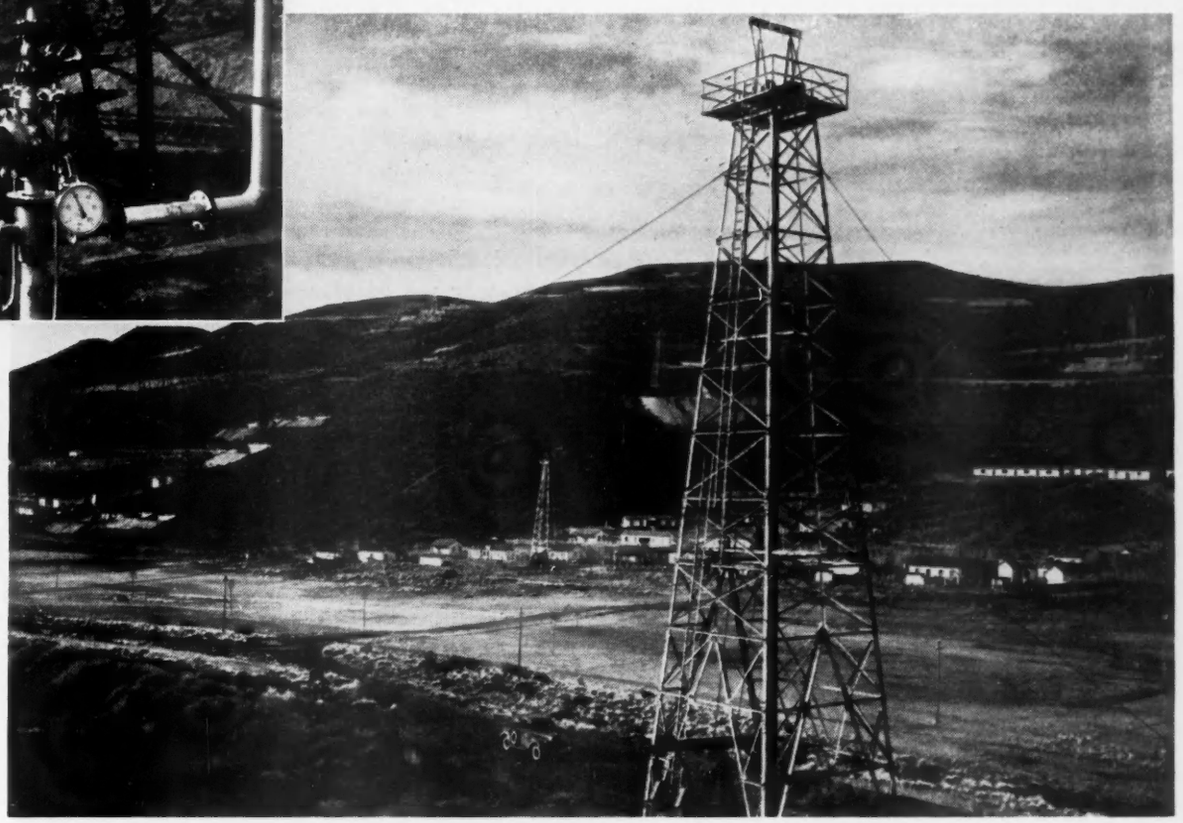
Argentina is charging itself with the entire responsibility for the nation's total output. Through the decree of 1924 which canceled concessions held in the country by private enterprise, allowing operation of producing concession to those already engaged in producing developed properties, YPF was given the responsibility for finding and exploiting what oil may lie in some 90 percent of the country's areal extent. There has been no softening of the nationalistic attitude on the part of the government through several changing administrations.

Occasionally there have been rumors that the private companies may have an opportunity to expand their activities, but experienced observers believe it unlikely that they will be permitted to acquire additional acreage for exploration. The most prevalent rumor has been that



Left: Casinghead connections on flowing well in Comodoro Rivadavia area. Comparatively few wells flow naturally, and several hundred are off production for lack of pumping equipment.

Below: View of YPF's Trebol camp in Comodoro Rivadavia shows typical terrain for this area.



the companies may be allowed to join with government in formation of mixed companies, part private enterprise and part government. However, it is not likely that the Argentines would allow this on any basis whereby they would not retain control of each company so formed.

In sweeping changes made during early October, the directorate of YPF was completely revised. This is looked upon as one of the most encouraging developments in some time. They see in the present setup greater hope for fulfillment of the aims of the organization than had been held previously. The new leaders possess backgrounds of technical knowledge and experience in far greater abundance than formerly was true. The organization had been unfortunate during the past couple of years in losing the services of more than 200 experienced men at various levels of responsibility.

The thinking of at least some members of the Congress has been apparent at the present session, when at least one senator came out definitely in favor of making some kind of dispensation whereby the private companies might be allowed to expand within controlled limits. The senator called for adoption of an oil policy that would not leave private enterprise in constant fear of nationalization or expropriation. He does not propose that the operations of the national company should be hindered, but suggests a system whereby the private companies who have been in the country all these years be given an opportunity if they so desire, to explore in areas where the Yacimientos Petroliferos Fiscales cannot, or does not wish to operate.

He described his plan as supplementary to, and a fortification of, the present system. In making his proposal Senator Durand pointed to the U. S. which could not have reached its present state of oil development with operation of the entire industry by one company with only one set of experienced leaders and no competitive urge. He compared the 30,000-odd companies operating in the U. S. with the five or six which have operated in Argentina.

Such proposals as these are not necessarily indicative of the thinking of very many of the leaders of the country, but they are an indication of a desire on the part of some to attempt to force more rapid development of resources through competition between various units of private enterprise.

Argentina has never in modern times been self-sufficient as regards the balance between production and total consumption, but whereas it once produced about 60 percent of its requirements, the figure has now become, through production declines and increased consumption, near 42 percent. At present rates of withdrawal, unless oil is discovered in substantial quantities, and made producible within a comparatively short time, the country will have reduced its sources to very near the stripper stage shortly after the expiration of the first Five-Year Plan.

Alaska

Left: This Eskimo comes up with a novel form of transportation over the soft ground. Huskies pull his barrow, which has two 50-gallon oil drums for wheels. When, the tundra is frozen solid in the winter, He'll use a sled.

Below: A helicopter from a Coast Guard ice-breaker flies in the mail. This was the first such aircraft some of the men had ever seen.

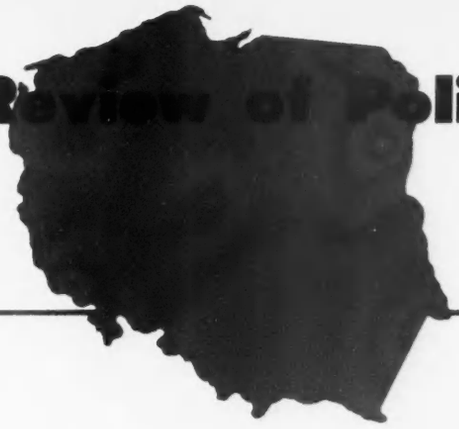
The Navy has until the summer of 1950 to find for Congress the answer to this important question: Is there worthwhile oil in Navy Petroleum Reserve No. 4, and is it worth commercial development? Answering this question is the immediate job of Arctic Contractors, a combination of two civilian firms hired by the Navy to handle its oil explorations. These pictures show life at Point Barrow.

Acme Photos

Left: Power plants are mounted on sleds, called "Wannigans," which will be hooked to a cat-train for transportation to outlying bases.

Right: Transports that bring food and other supplies to Point Barrow have only three weeks during the entire year when they can unload this far north. Because there are no dock facilities, lighters must unload the supplies on the beach. Crews work around the clock during this period.

Review of Polish Oil Operations



RECENT ISSUES of *Nafta*, the official publication of the Polish Petroleum Institute, furnish data on the progress made by the Polish oil industry during the first six months of 1947. A summary of these data and other pertinent information, as reported by *Nafta* are given in this article.

THE Polish oil industry is nationalized and operates under a three-year plan, the purpose of which is to make Poland independent of oil imports by the end of 1948. All quotas set under this plan for the first half of 1947 have been exceeded. Measured by standards of the oil fields of this area and considering the conditions under which the work had to be done, the progress made was very substantial.

During the first half of 1947 a total of 62,469 feet was drilled. This compares with 41,661 feet drilled during the first half of 1946, and represents an increase of about 43 percent. Table 1 shows the comparative monthly drilling data for 1946 and 1947. The figures bring out the progress which was made from month to month in increasing the number of feet drilled.

This table cites the relation of exploratory drilling to overall drilling operations. During the first half of 1946 the number of feet of exploratory drilling represented 8.5 percent of the total footage drilled. In the first half of 1947 this ratio was increased to 29 percent. This increase is a result of the program which sets up the discovery of new reserves as the primary goal of all the operations of the oil industry. Such a policy was necessitated by the fact that annexation by the U.S.S.R. of the eastern part of Poland, deprived this country of about four-fifths of its prewar oil producing potential.

Further improvement of drilling operations may be expected in view of the fact that during the first half of 1947 drilling equipment purchased in the U. S. began to arrive. This includes portable rotary rigs, internal combustion engines and miscellaneous tools used in rotary drilling. Good progress also has been made in returning to the country the equipment moved from Poland by Germans near the end of the war. About 540 tons of miscellaneous drilling, production and refining equipment have been moved so far from the American and British zones of occupation. Large amounts of important well records have been found in Germany and are to be returned in the near future.

Production

In view of the fact that oil fields left to Poland are small, shallow and depleted to a high degree, attempts not only to maintain but to increase the level of crude production represented a difficult task. This has been accomplished by workovers and deepenings of the existing wells, by drilling new wells in the known fields, by gradual replacement of the wornout production equipment, and by modernization of production methods. Production during the first half of 1947 was 455,256 barrels as compared with 411,698 barrels during first half of 1946, which represents an increase of 10.5 percent. It is estimated that actual increase was around 17 percent, considering the natural decline of the fields which existed before the efforts were started to reverse the trend. Table 2 shows a month-by-month comparison of production records during the first parts of 1946 and 1947.

As is the case with drilling operations, the situation in the producing branch of the industry should continue to improve with the arrival of new equipment purchased abroad. Five hundred sucker-rod pumps and ten pulling machines have been received so far from the U. S.

Natural gasoline is an important product of the Polish oil industry. During the first half of 1947 production of natural gasoline was increased by 77.5 percent in comparison with the first half of 1946. These results were brought about by work under the "Natural Gasoline Program," which embraces building of new gasoline plants and modernization of the old ones. A new plant was put in operation in Roztoki in March, 1947. Another was to be completed by the end of the year in Wankowa. The plant in Glinnik Mariompolski is being modernized. In conjunction with this program networks of gas lines in different areas are being rebuilt and relaid for greater efficiency of operations.

As far as natural gas is concerned, special efforts are being made to better utilize and conserve this important resource. As a result, the amount of gas consumed by the industry during the first half of 1947 was 92.5 percent of the amount used during the first half of 1946 despite increase in all activities.

TABLE 1

MONTH	No. FEET DRILLED	
	Exploratory Drilling	All Drilling
January—1946	54	4,875
1947	1,122	6,981
February—1946	396	4,503
1947	1,431	6,621
March—1946	378	5,316
1947	3,153	9,681
April—1946	213	7,782
1947	3,426	11,124
May—1946	1,173	10,038
1947	4,416	13,266
June—1946	1,338	9,147
1947	4,599	14,796
Total—1946	3,552	41,661
1947	18,147	62,469

Refining

Polish refineries handled during the first half of 1947 a total of 610,419 barrels of crude as compared with 392,607 barrels run to stills in the first half of 1946. This increase of around 75 percent was a result of the rebuilding of war-destroyed refineries and the modernization program still being continued. Corresponding increases were attained in manufacture of different refining products.

Last July, 20 exploratory wells were drilling. The results achieved so far are discoveries of new gas production. The new gas field, discovered by the end of 1946 near Debowiec in Cieszyn Silesia,

represents a substantial gas reserve. The field now is being defined by drilling. Wildcat wells in Szalowa near Gorlice and in Wojslaw near Mielec should open two more new gas fields. Gas indications were found in the wildcat at Siedlce near Bochnia.

Exploratory drilling is slowed by communication difficulties. The wells are scattered over wide area and are located mostly in a difficult terrain. Roads are in a bad state of repair and lack of trucks makes it difficult to keep the wells supplied.

Modernization

It was stated above that some of the production increase was due to modernization of methods. This modernization is carried along several lines. For instance, it was only recently that the practice of swabbing or bailing of wells for production was discontinued. Many shallow wells were produced in this manner until last year. Pumping is now universally used. Large machine shops in Glinnik Mariompolski have been rebuilt and manufacture of sucker-rod pumps has been started. Of other methods of production, rotation gas lift is well adapted to local conditions and plans are to make application of this method.

A majority of central pumping power installations are still powered by steam engines. A program of electrification has been instituted. Four such installations have been changed to electric power during the first six months of 1947 and work is progressing on electrification of three more. In conjunction with this program special agreements have been made with the electric industries. Power plants previously owned by the oil industry have been turned over to the electric cooperatives. In return, the oil industry receives the electric power at special low rates and the network of high voltage lines is expanded.

Three electric rigs now are being assembled.

The oil mining experiment was officially abandoned June 23, 1947. There were two reasons for this decision. First was the question of safety. The oil mined in this project is 57 degrees API and has a very high gasoline content. It was decided that the danger involved in operations is too high, despite all the modern precautions taken. Second, the cost of further work and of maintenance was entirely out of proportion to the production which could be expected.

The project was started in May, 1946. A total of 2485 feet of inclined shafts were completed to the time of liquidation. Twenty-two drainage holes were drilled, ranging in length from 21 to 147 feet each. Total production amounted to only 728 barrels.

The opening of new research laboratories in Krosno took place in July, 1947. Because of the scarcity of building materials the space now available is small and provisions have been made for future expansion. The work which is contemplated includes chemical research for the refining branch of the industry, mechanical equipment research, and work on different drilling and production problems.

One of the projects, now already well advanced, which will be carried in these laboratories is systematic determination of porosity and permeability of the producing zones of different fields. This is the first step in the planned program of secondary recovery. The determinations are made currently on all the drilling wells. This part of the work is hampered by the fact that a large portion of drilling is with cable tools. Cable-tool core barrels have been ordered abroad.

Great emphasis is placed on vocational training. Two vocational schools are in operation for young men who plan to make oil their life's work. Three schools have been opened for workers with long field experience.

Associations

In June, 1947, a meeting was held of the Association of Engineers and Technicians of the Industry of Liquid Fuels. The association is very active and the purpose of the meeting was to work out the details of different activities and to make the plans for the future. The association is composed of seven sections, located in different oil centers of the country.

In addition to cooperation with the official agencies in planning and supervising the technical phases of the three-year plan of the industry, the association carries its work along two general lines, educational work and standardization of equipment. Other forms of activities are planned, such as contacts with oil industries of other countries.

The educational work includes help to the Petroleum Institute in carrying out the vocational training program, cooperation with the mining academy in Krakow in working out programs for education and training of petroleum engineers, and preparation of general lectures for administrative employes of the industry. An annual meeting is held, during which members are acquainted with the technical progress made during the year.

The standardization work will cover, eventually, not only the equipment but also the records, clerical forms and methods of accounting. At present the work is carried on in cooperation with governmental agencies on standardization of casing and rotary tools.

TABLE 2

MONTH	Crude Oil Production	
	Barrels	Percent
January—1946	67,207	100
1947	74,851	111
February—1946	59,799	100
1947	65,986	110
March—1946	69,685	100
1947	76,516	110
April—1946	68,642	100
1947	76,065	111
May—1946	73,808	100
1947	80,083	108
June—1946	72,557	100
1947	81,755	113
Total—1946	411,698	100
1947	455,256	110.5

Reorganization

Effective July 1, 1947, the CZPPP (Central Governing Body of the Industry of Liquid Fuels) has been incorporated into the Heavy Industries Section of the Department of Industry and Commerce. This section has authority also over coal, metallurgical and electrical industries. Prior to this change the relation of CZPPP to different governmental agencies was rather indefinite. With the change complete reorganization of the industry is planned.

Under the proposed program, which has not been approved so far, the oil industry would be placed under the authority of a general director, with considerable discretionary powers. The whole industry would be divided into departments of exploration, production, natural gas, refining, supplies and distribution. The headquarters of each of the departments would be located in the center of its activity. For instance, the headquarters of the department of supplies would be located in Glinnik Mariompolski, the location of the oil equipment machine shops. Directors in charge of different departments would have authority in matters pertaining to their departments and would in turn delegate considerable authority to those in charge of different activities of the department.

After two years of operation as a nationalized industry, the Polish oil industry is already plagued with characteristics of this type of enterprise; interference by different governmental agencies, endless reports, lack of well-defined authority, reluctance to take initiative without orders from above.

Current Operations

Last data on the Polish oil industry, given by the available issues of *Nafta*, are for July, 1947. During this month 66 wells were drilling, and a total of 13,821 feet were drilled. There were 2415 producing wells and their production was 82,199 barrels. This represents an average production of around two barrels per well-day. The refineries handled a total of 120,435 barrels of crude. Of this amount, 29,889 barrels were imported.

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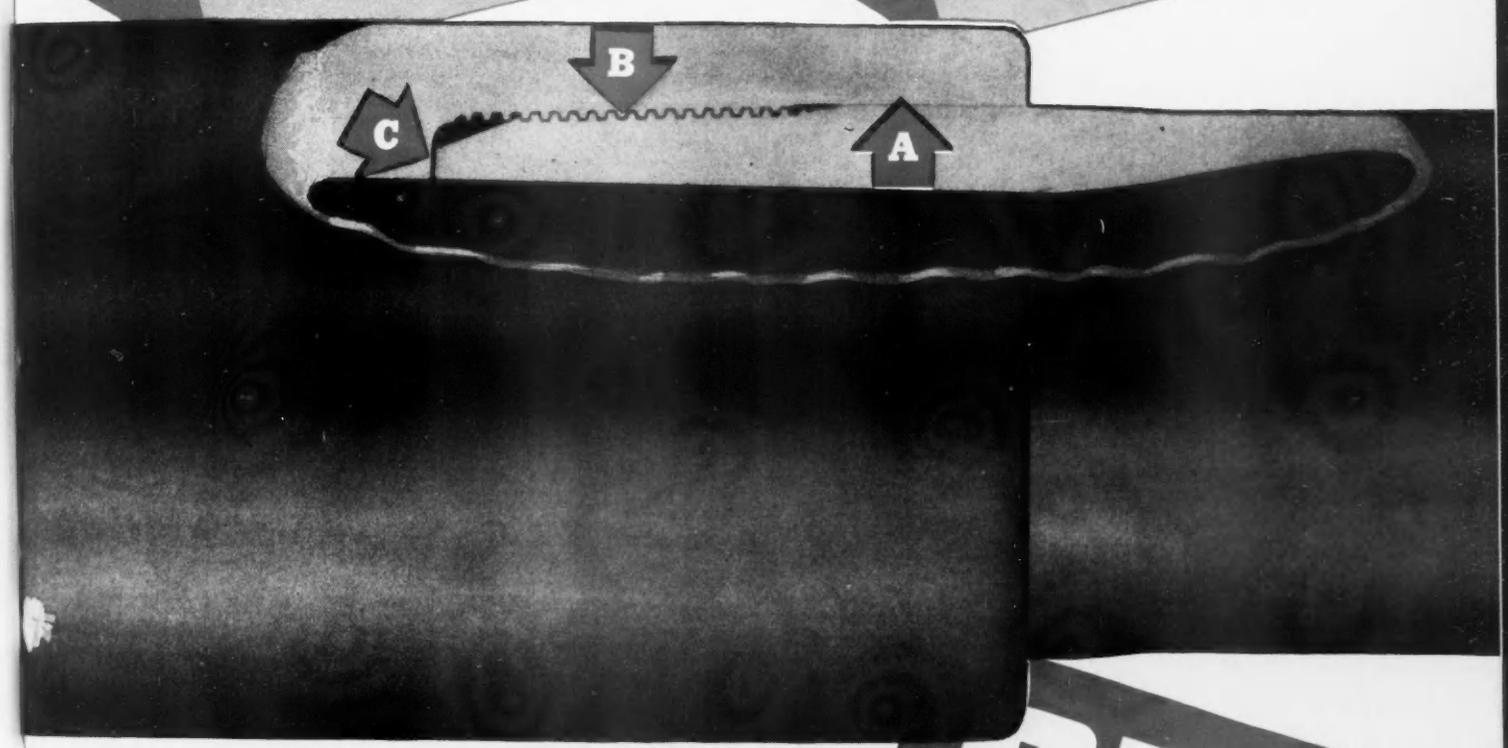

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RUSSIA'S OIL GRAB

IN AUSTRIA, HUNGARY AND ROUMANIA

By HENRY OZANNE
Staff Writer

BEHIND the Iron Curtain, in Eastern Europe, Russia is steadily draining the oil of three satellite nations under a program by which—it is now clear—Moscow intends to control for its own purposes the whole petroleum industry in the Balkans. Politically, such domination by the Soviet Union is a violation of the peace treaties guaranteeing protection of American and British rights; and economically, the Russian policy means the oil impoverishment of the people over whom the U.S.S.R. exercises its power.

A number of current developments highlight Russia's oil plans in Roumania, Hungary, and Austria, and give rise to widely expressed fear that all U. S. petroleum interests between the Rhine River and the Black Sea may be lost unless forthright action is taken by the U. S. government to save the properties. The following is a resume of crucial events in each of the three countries.

Roumania

In Roumania the Communist-controlled Roumanian government is seeking to purchase in the U. S. $7 million worth of oil field equipment. It is not specified whether any of this equipment will go to the British or American companies operating in Roumania, but suspicion persists that it is all intended for the Russians. Of a number of foreign companies which operated in Roumania before World War II, all have been liquidated except four: Romano-Americana, oldest affiliate of Standard Oil Company (N. J.), established in 1904; Astra Romana of the Shell group; Unirea, and the smaller Steaua Romana, partly British-owned. The dominant operator, politically, now is the Russian company, Sovrompetrol.

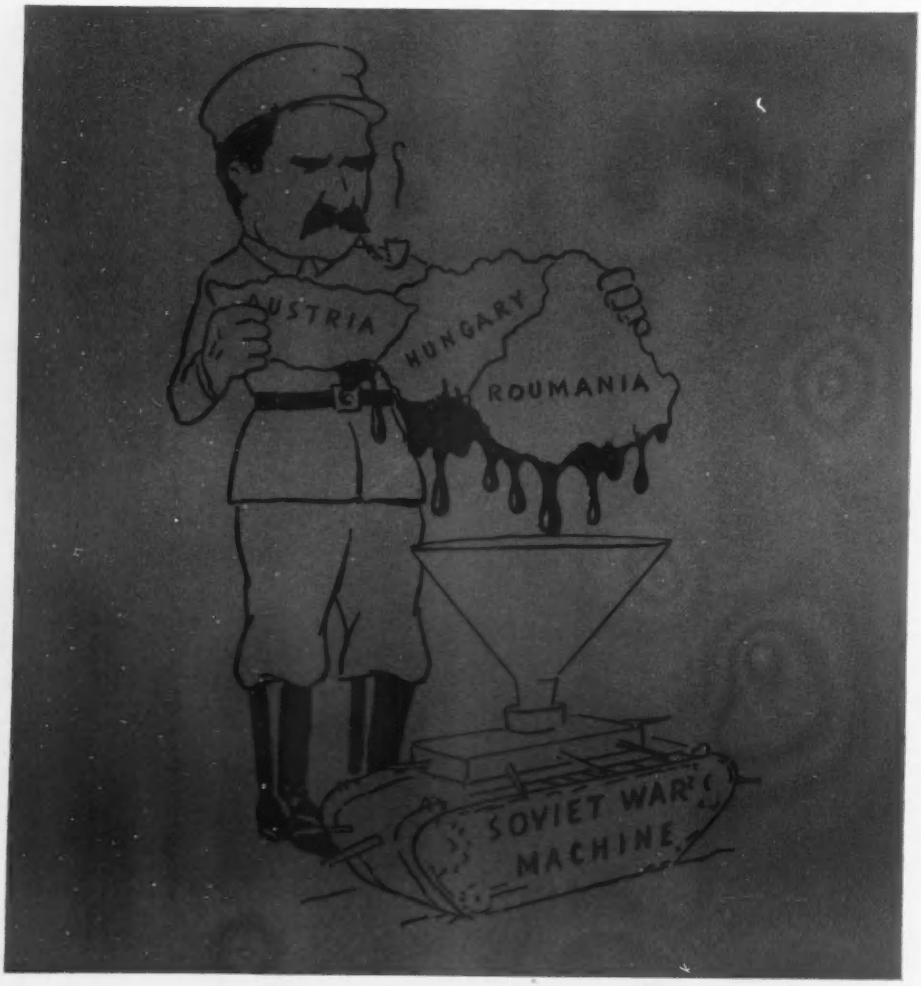
At the present time 60 percent of Roumanian oil production is being delivered to Russia as war reparation, or is passing through Russian hands in barter deals in Southeastern Europe. The Roumanians are receiving no cash payment for any of these shipments. The 40 percent of Roumania's oil which is consumed inside the country is equivalent to less than one-half the nation's prewar demand.

Furthermore, neither the American nor the British companies can export any oil at all, and hence are unable to engage in any cross-border trade. All exports are the sole privilege of Sovrompetrol, which presumably may be the only recipient of any of the oil field equipment being sought in the U. S. The purchase is to be guaranteed by a gold loan from the Roumanian state bank.

Items wanted by the Roumanian government, as learned from Soviet sources, include about 300,000 feet of drill pipe, 14 drawworks units, electric motors, gears, hooks, rotary drilling hose, drill collars, drill stem, rotary rock bits numbering several hundred, measuring devices, fishing tools, 32 portable hoists, pumps, compressors, 300,000 feet of sucker rods, and cars and trucks.

The order, which WORLD OIL here reveals for the first time, has provoked a storm of protest from the American industry. Many industry authorities have been contending that we are too short of field equipment to supply even the Marshall Plan countries, and now learn that one of the largest export deals pending is apparently designed to benefit one Russian company.

The equipment is for use in connection with Roumania's stepped-up production program. Under Russian dictation, Roumania plans to drill in 1948 a total of 1,150,000 feet of hole and to increase oil production to 32 million bar-



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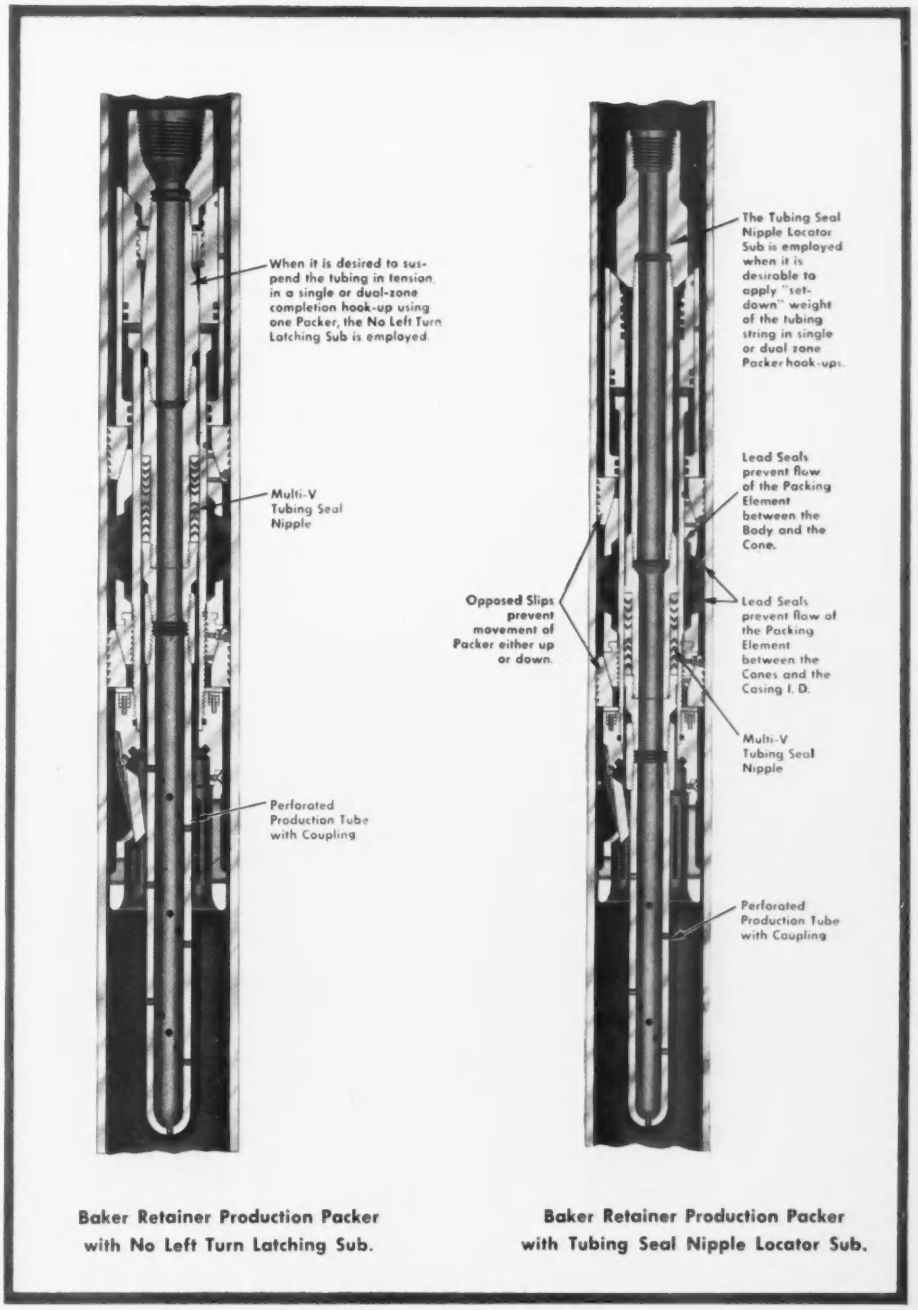
wide popularity because of its effective application to many needs in producing wells. It can be set and used for making a flow test, utilizing the Packer for production through the tubing, if the zone proves productive. If not productive, the zone can be squeeze cemented through the Packer. One Packer provides for production of two zones, either simultaneously with segregated production, or from each zone separately at different times. For complete flexibility of two-zone production, a Baker Change-Over Flow Tube (see illustration) with two Packers may be used. For three-zone production only two packers are used.

The Baker Retainer Production Packer is used for single-zone installation to prevent gas from cutting holes in the casing (often started by thread leaks) by transferring the pressure from the casing to the tubing. If and when the tubing leaks, it can be pulled, repaired and replaced through the Packer. The Packer will protect the casing, when corrosive fluid is being produced or injected, by allowing the annulus to be filled with oil and confining the corrosive action to the tubing only.

An interesting use of the Baker Retainer Production Packer is for pumping or flowing an upper zone through the tubing, and flowing a lower zone through the annulus between the tubing and the casing. This hook-up calls for use of the Baker Change-Over Flow Tube, and in addition to permitting segregated production as mentioned above, production of both zones through the tubing may be secured without removing the tubing string from the well.


When it is desired to suspend the tubing in tension in a single or dual-zone completion hook-up using one Packer, the No Left Turn Latching Sub is employed.
Multi-V Tubing Seal Nipple
Perforated Production Tube with Coupling
The Tubing Seal Nipple Locator Sub is employed when it is desirable to apply "set-down" weight of the tubing string in single or dual zone Packer hook-ups.
Lead Seals prevent flow of the Packing Element between the Body and the Cone.
Opposed Slips prevent movement of Packer either up or down.
Lead Seals prevent flow of the Packing Element between the Cones and the Casing I. D.
Multi-V Tubing Seal Nipple
Perforated Production Tube with Coupling

Baker Retainer Production Packer with No Left Turn Latching Sub.

Baker Retainer Production Packer with Tubing Seal Nipple Locator Sub.

GET ALL DETAILS

If you have any production problems which might be solved by the use of a Baker Model "D" Retainer Production Packer, we suggest you contact the nearest Baker representative, who will gladly furnish helpful recommendations. See also the 1947 Baker (or Composite) Catalog for complete descriptions.

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rels; as against 570,000 feet to be drilled for 1947 with a total production of 29 million barrels. No new fields have been discovered in Roumania and the augmented production would come from the Ploesti region, including the fields of Baicoi-Floresti, Liliesti-Tintea, Boldesti, Ceptura-Urlati, Moreni-Piscuri and Gura-Ocnitei; and from the field of Berca in Buzau.

Jersey Standard's Romano-Americana is encountering difficult operating conditions. The company has been unable to obtain a Roumania entry permit for any of its American officials despite the fact that such applications have been pending for more than a year. Several months ago Roumania (again under Soviet pressure) ordered the American company to dismiss nearly all its key management and technical employes.

M. Lassersons, the Roumanian oil representative who arrived in Paris recently, stated that he was not authorized to discuss with the French government the question of compensation for the French-owned companies taken over by the Roumanian government. Nor could he discuss the problem of settlement of war damage claims, reported Reuter. The object of his visit, said M. Lassersons, who represents the Soviet-Roumanian oil combine "Sovroman Petrol," was to ascertain which products France would agree to export against imports of Roumanian oil. Roumania agreed to supply France with oil products under a trade pact between the two countries signed a year ago, but as no oil arrived France stopped exports to Roumania.

It is officially announced that 85 percent of the oil refineries in Roumania destroyed by the Germans are now working again. Their total capacity is at present over 6 million tons a year.

Hungary

In Hungary, the Hungarian-Communist government is reported preparing to nationalize the oil fields of Magyar Amerkai Olajipari Reszvenytarasag (Maort), Jersey Standard subsidiary. Russia has ordered a three-year production program in Hungary to increase production by 15,000 barrels monthly above current 320,000 barrels a month levels, and has decreed that all oil import-export trade is a state monopoly.

Hungary, using the same Russian tactics as were imposed on Roumania, accuses the company of sabotage in restricting production, but a company official explains that the real reason for Hungary's present shortage of gasoline, the fact on which Hungarian complaint is based, is because the Hungarian government has made gasoline commitments with other countries and "now finds out it can't fulfill them—so the blame goes on us."

Hungary has declared that oil shipments to Russia will be increased and has issued a decree covering petroleum operations. Paul Reudemann, American director of Maort, is quoted by the Associated Press out of Budapest as saying that the decree "is almost a complete control of the company" and that maximum production quotas set by the government "would ruin the fields in a year and a half."

Minimum production, under the Hungarian decree, is fixed at about 4 million barrels a year for the American field with a stipulated price of about $1.40 a barrel, insufficient to cover operating costs. Ruedemann pointed out that one clause of the decree providing for continuous well operation would result in waste and field destruction. The company charges that Russian management already has caused $25 million damage to the field.

Austria

In Austria, less than 200,000 barrels of a monthly production of 490,000 barrels are being made available for Austria's own petroleum needs. The rest, like Roumania's and Hungary's oil, is flowing into Russia. The Soviet Union, in response to a recent demand made by the Allied Control Commission, refused to specify what amounts of oil Russia is taking or what payment is being made for them.

The Russians claimed as transferable German assets all oil properties operated by the Nazis during the war and last August three truckloads of Red soldiers seized the Lobau refinery on the outskirts of Vienna while the Allied Control Commission was striving to straighten out conflicting claims.

The Russians have claimed discovery of a new field in the Zisterdorf area, and reported that 55,000 cubic meters of gas was blowing off the discovery well daily. However, Soviet officials denied a request of Austrian authorities for some of the gas for use in Vienna.

In all three countries the pattern is the same: further and tighter restrictive operating conditions for the Americans and British leading to actual if not legal expropriation of the properties, and an increasing flow of oil from Russia's subjected peoples into the Soviet Union. The plan undoubtedly is merely one link in the war chain Moscow is feverishly forging for the next military conflict.

Austria's Plight Grows More Acute

The Austrian internal oil situation is becoming increasingly acute and Austria is having to spend dollars importing oil from the West, while her own oil is being exported by Russia contrary to all agreements. In October, 1946, the Austrian oil needs were 57,000 tons (6.7 barrels to the ton) and Russia's deliveries were 40,000 tons.

In September, 1947, Austria's requirements were 71,000 tons, and Russian deliveries were only 25,800 tons. Between 60,000 and 70,000 tons of crude are being produced monthly from the Zisterdorf fields, but much of this is being compulsorily exported to Czechoslovakia.

Czechoslovakian official trade returns for September show that more than 42,000 tons of Austrian oil were imported.

Major General Alexander Galloway, the British High Commissioner, recently tabled a resolution before the Allied Council asking that Austria should be allowed to have control over her own oil products.

The U. S. and Britain have jointly made an official protest against the seizure by Russia of the Lobau refinery, and it is probable that this protest will bring to a head the long-standing dispute between Russia and the Western Powers over the Austrian oil industry.

Italian Refinery Planned

Mantua, between the Lake of Garda and Bologna in north Italy will be the site of a refinery to be erected by Industrie Chimiche Italiane Petroli (ICIP). The necessary authorization has been granted by the Ministry of Industry in consultation with the Ministry of Finance. Planned throughput of the refinery is 1,530,000 barrels annually, but neither the quantity nor quality of the derivatives to be obtained has been specified.

Danish-Soviet Trade

The Danish foreign minister recently announced in a statement on the progress of Danish-Soviet trade that negotiations were under way for Soviet gasoline deliveries.

Shale Pits Restored

The restored oil shale pits in Esthonia are now producing considerably more shale than before the war. Ten new pits are being sunk. Mining and transport in the restored pits has been completely mechanized. Wooden head frames are being replaced with metal ones and concrete bunkers are being erected for loading the shale onto railway trucks.

Pakistan Test Planned

Burmah Oil Company (India Concessions) Ltd. is preparing to drill a 10,000-foot test at Lakhra, near Budhapur in the province of Sind, Dominion of Pakistan. Work is expected to start early in 1948. Two new companies, Shell Company of Pakistan and Burmah Shell Oil Storage and Distributing Company of Pakistan recently have been registered in London.

Pipelining IN THE MIDDLE EAST

By BURT E. HULL
Vice President, The Texas Company;
President, Trans-Arabian Pipe Line Company

THIS ARTICLE describes some of the unusual engineering problems and peculiar circumstances affecting the construction of large-diameter pipe lines across the several Arabic-speaking countries included in the region of 1,300,000 square miles (equivalent to more than one-third of the area of the U. S.), lying between the Persian Gulf, the Mediterranean and Red seas, and south of the Turkish and Soviet Republic frontiers.

THE Western Hemisphere is often referred to as either "the Occident" or "the Americas." North and South Americans frequently refer to the Eastern Hemisphere collectively by the names of one or more of its continental components. But the expression "Europe, Africa, and the Orient" is heard more frequently than "Europe, Africa, and Asia." The Orient then means usually all of that part of the Asiatic continent lying east of the Mediterranean.

The Orient is now referred to more specificially as the "Near East," the "Middle East," and the "Far East," with some minor differences of interpretation of regional boundaries of these three main sub-divisions.

This paper is based on the assumption that: (1) the oriental Levantine countries of Palestine, Trans-Jordan, Syria, and Lebanon—lying immediately east of the Mediterranean—are the "Near East"; (2) a region of 1,388,450 square miles, including Iran, Iraq, Kuwait, Bahrein Island, Saudi Arabia, and the remainder of the Arabian peninsula (equivalent to 46 percent of the area of the United States) is the "Middle East"; and (3) the remainder of the Asiatic continent is the "Far East."

The Middle East flanks the route eastward from the Mediterranean through the Suez Canal and the Red Sea to the Indian Ocean, and lies squarely across the oldest known overland trade routes in the world between the three continents of Europe, Asia, and Africa. The comparatively recent spectacular development of the Middle East as an important oil-producing region has attracted worldwide interest in its petroleum resources.

Extensions to the earlier producing areas and discoveries of new areas of prolific production, stimulated by the tremendous increase in consumption of petroleum products in the Eastern Hemisphere during the past 12 years, accounts for the daily average production of crude oil increasing from 230,000 barrels in 1935 to 830,000 barrels in 1947. Meantime, estimates of proved reserves have increased from an insignificant figure a few years ago to the substantial proportion of 50 percent or more of the world's total. During World War II the capacity of the world's largest refinery, the Anglo-Iranian refinery at Abadan, was increased to about 400,000 barrels daily. Four other Middle East refineries, the Arabian-American at Ras Tanura, the Bahrein Petroleum Company refinery on Bahrein Island, the Consolidated Refineries, Ltd., at Haifa, and the Iraq Petroleum Company's small refinery at Tripoli, account for a total Middle East crude refining capacity of 730,000 barrels daily. Substantial additions are planned to meet part of the prospective increase of 1 million barrels in Eastern Hemisphere daily consumption during the next five years.

Some of this additional consumer demand will be met by Mediterraneann coastal refineries and others being reconstructed in central and western Europe. From Persian Gulf producing areas, shipments to points west of Suez must be made by tanker through the Red Sea and the Suez Canal to Port Said, involving a canal toll and an expensive tanker haul of 3650 miles, or, at a lower cost by pipe line, 1000 miles or less to some eastern Mediterranean crude-oil loading port, and thence by tanker to destination.

Middle East Transcontinental Lines

Iraq Petroleum Company has at present the only pipe outlets to the Mediterranean. They are two 12-inch lines, each about 650 miles long from the Kirkuk Field in Iraq to Haifa and to Tripoli, respectively, having a combined capacity of about 96,000 barrels daily. The Consolidated refinery at Haifa and the Iraq Petroleum Company refinery at Tripoli can absorb the entire throughput of both lines. By December, 1947, Iraq Petroleum Company expects to complete a new 16-inch pipe line from Kirkuk to Haifa, which will provide an additional daily capacity of 120,000 barrels.

Trans-Arabian Pipe Line Company is making initial preparations to construct 1040 miles of 30- and 31-inch pipe line, with a capacity of 300,000 barrels daily, from Arabian American Oil Company's fields along the west side of the Persian Gulf to a new Mediterranean shipping port to be constructed near Sidon, Lebanon, scheduled for completion about January 1, 1950.

Middle East Pipe Line Company is preparing to construct, during 1950 and 1951, about 900 miles of the biggest-inch oil pipe line yet planned, with a throughput capacity of 500,000 to 550,000 barrels daily, from Abadan and the Burghan Field in Kuwait, to a Mediterranean terminus yet to be selected. Iraq Petroleum Company is planning the construction during 1952 and 1953 of a new 24-inch line, capacity about 250,000 barrels daily, from Kirkuk to Tripoli.

These new trancontinental carriers, with Iraq Petroleum Company's lines, will provide a total pipe line outlet from Middle East oil fields to Mediterranean ports of 1,300,000 barrels daily by January 1, 1954, or shortly thereafter.

The new lines will relieve the present tremendous world demand for crude oil in two ways: Not only will they provide a new source of oil for the stricken countries of Europe, but they will benefit the U. S. by reducing the present heavy drain on Western Hemisphere reserves.

Competent authorities agree that the U. S. alone cannot continue to meet the steadily rising demand for oil in both hemispheres. Although crude oil

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is being produced in the U. S. today at the maximum efficient rate, this country is already a net importer of crude, and is faced with rationing of gas and heating oil for homes. The companies which are making investments in the Middle East are convinced that the Trans-Arabian pipe line will provide insurance against a possible future shortage of oil in the Western Hemisphere.

At the present time crude from the Persian Gulf which is destined for Eupore must be hauled by tanker about 3600 miles around the Arabian peninsula, through the Suez Canal, and into the Mediterranean. The Trans-Arabian line will cut 2600 miles off this journey, and the estimated cost will be about one-third of the estimated tanker transportation cost from the Persian Gulf, plus Suez Canal tolls. Furthermore, a shortage of tankers is already developing.

Exporting Americanism

Now a word or two as to the export of steel for these projects. Probably no other project in the world will produce as much oil for as little steel as this one. I estimate that a ton of steel in the Middle East could actually bring to the world markets, including the United States, ten to 20 times as much oil as a ton of steel used anywhere else in the world. Moreover, there are no tube mills anywhere outside the U. S. capable of manufacturing pipe larger than 16 inch in diameter. In January of this year Consolidated Steel Corporation was the only concern having a source of steel available for manufacturing any pipe at all for the Trans-Arabian project. Consolidated's output is limited to the quantity of steel plates available from United States Steel Corporation's Geneva mill near Provo, Utah. This steel is suitable for making large-diameter electric-welded pipe. High transportation costs to the east of the Mid-Continent area limit its market to the Pacific Coast or to foreign customers.

One year ago Consolidated's manufacturing capacity was less than a mile of pipe per day. This is the normal Pacific Coast demand. Trans-Arabian Pipe Line Company contracted with Consolidated for 1040 miles of 30-inch pipe, and underwrote the cost of additional facilities to increase Consolidated's capacity to three miles per day.

The pipe lines of the Middle East will use less than two-thirds of the steel tonnage required to build the 250 new tankships which would be needed to perform an equivalent service. The steel now being produced for Trans-Arabian at the Geneva plant could not be used economically at any point east of the Rocky Mountains because of transportation differentials. Moreover, only one other mill in the U. S. can fabricate these plates into pipe.

Engineering Characteristics and Other Features

Circumstances affecting and controlling engineering design and construction of the pipe line projects mentioned herein are basically the same. Each line will traverse for the greater part of its length predominantly arid sections of country sparsely populated by nomad Bedouin tribes. Shifting sand dunes may hamper construction to a minor extent in the immediate vicinity of the Persian Gulf, but for hundreds of miles each pipe line will cross rolling, unbroken, hard-surfaced plains at elevations ranging from 1000 to 2000 feet. Rainfall in the entire region, with the exception of the Tigris and Euphrates River valleys, does not exceed four inches per annum. Consequently, drainage is accommodated by occasional shallow wadies or "dry" water courses, which are minor obstacles.

There are no railways, fences, or other obstructions. Vegetation is so sparse that it may be said to be actually non-existent. There are no improved highways or trails. None are required because in most of the areas traversed, except where there are outcrops of disintegrated stone, the surface is sufficiently stable and uniform to sustain vehicular traffic without grading or surface improvement. In many respects the Middle East resembles the plateau region of northern Mexico and the Permian Basin area of West Texas and New Mexico. It lacks the advantages of railways and highways, but offers a number of compensating advantages.

On the approach to the Mediterranean, routes which now or may hereafter terminate in Palestine must descend and ascend the escarpments on each side of the Jordan River valley, and cross the river itself 800 feet below sea level. Farther northward, routes must cross through passes at elevations of 2000 to 3000 feet through the Lebanese and Anti-Lebanese Mountains, near the seacoast and running roughly parallel thereto. Some peaks exceed an elevation of 9000 feet and are snow-capped during winter months.

Circumstances controlling the design of the Trans-Arabian pipe line indicate that the optimum for a normal daily throughput of 300,000 barrels is 30-inch-diameter pipe having wall thicknesses from one-quarter to three-eighths inch, conforming to the hydraulic gradient, and a combination of the initial with five intermediate pump stations, each to operate at a discharge pressure of 845 pounds per square inch at full load.

Trans-Arabian decided to lay 50 percent 30-inch pipe and 50 percent 31-inch pipe between each pair of pump stations, because this will permit shipment of 30-inch diameter lengths "nested" inside of 31-inch lengths, and will result in substantial economy in transportation cost.

The pipe will be shipped from Los Angeles in uniform 30-feet lengths, and welded by union melt process into 90 to 150-feet lengths at Mediterranean and Persian Gulf receiving and forwarding bases before being trucked overland.

The characteristics of the steel plate, and the cold working thereof during the fabricating process, will increase the yield point to 52,000 pounds per square inch. The pipe line is designed for a working stress of 32,800 psi, or 65 percent of the yield. Perhaps one-third of the line will be constructed aboveground, where hard rock prevents machine trenching. Expansion and contraction incident to atmosphere temperatures, ranging from 135° F. in summer to 20° F. in winter, presents new problems of design and construction. Large-diameter thin-wall pipe with this wide range in seasonal temperatures will require unusual construction precision. Misalignment of as little as one-half inch in a distance of 70 feet will impose an added 10,000 psi on the bending stress.

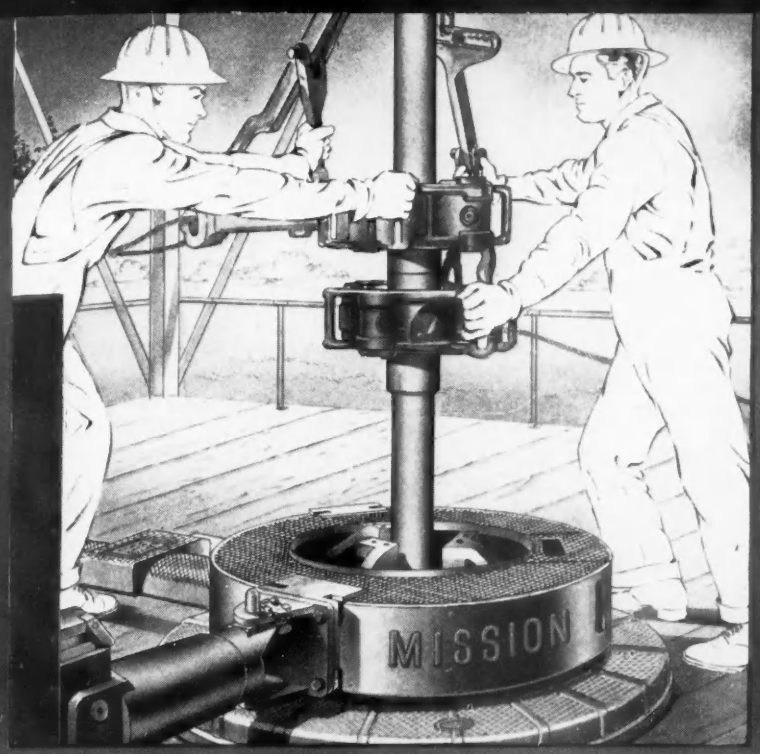
Pump stations will be an average distance of 175 miles from each other and, because of their complete isolation, each must be provided with water supply, laundry, schools, mosques and churches, commissary, housing, recreational and hospital facilities, and every other human need of an isolated community. In addition, barracks for a small garrison of soldiers must be provided. An adequate airplane landing strip, with housing for customs and immigration officials, will also be constructed.

The initial station in the Abqaiq oil field will be a 6000-horsepower steam-driven turbine centrifugal pump station. The five intermediate stations each will have four 1700-horsepower supercharged diesel-engine-driven centrifugal pumps connected in series, with one standby unit. Two diesel-engine-driven 750-kvh generators will be required for lighting, motor-driven auxiliaries, and other electrical energy demands.

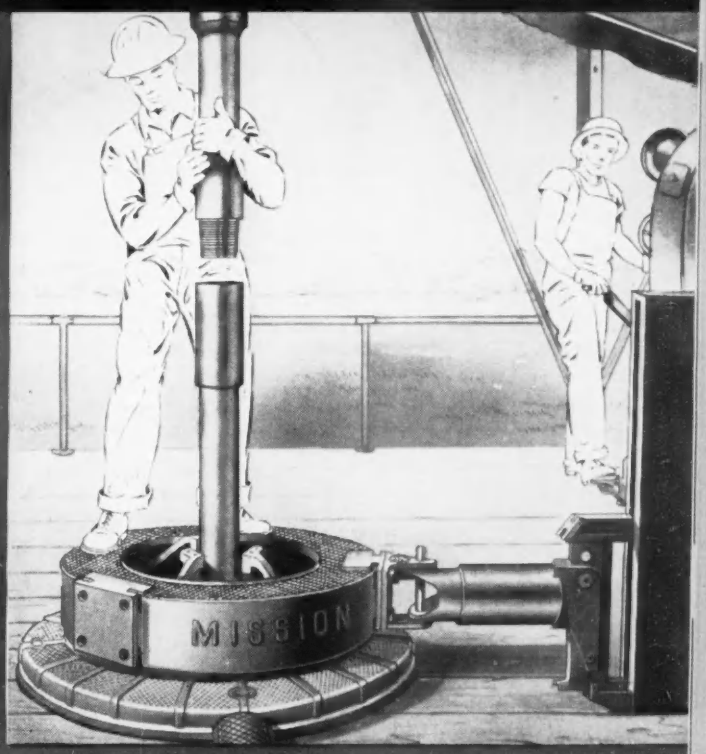
East Mediterranean Ports

There are no large bays or other well-protected natural harbors along the Mediterranean coast east or northeast of Alexandria, Egypt. Promontories at Haifa and Beirut undoubtedly provide some shelter from the southwest in Acre and St. Georges Bays, but neither has visible natural protection against westerly or northwesterly winter gales or storms, and there are no other deep-

Increased Efficiency!



Here the Slips are shown in lowered or engaged position for making up or breaking out a stand of pipe



Showing how lifting ring remains stationary, shielding the workmen from the revolving slips and rotary

INCREASED EFFICIENCY: When hand slips are used, round trips are the toughest, most back-breaking work the men do. MISSION Power Slips relieve the men of this gruelling labor, keep them fresh through the tour. The slips are highly efficient in operation. They swing to position like tongs, without the aid of a catline. Pressure of the driller's foot on a pedal lowers the slips smoothly and quickly, to grip the pipe. Another foot pressure raises and releases the slips.

INCREASED SAFETY: Manual handling of slips has been a leading cause of accidents. MISSION Power Slips reduce the chance of accidents to a minimum. Men are protected from moving parts by the stationary lifting ring, on which they can even stand while rotary is spinning.

INSTANT AVAILABILITY: MISSION Power Slips are always ready for instant use.

AMPLE CLEARANCE: Opening when slips are in raised position is ample to pass tool joints, pipe protectors, tubing catchers, etc.

ALL SIZES OF PIPE are handled, from 2⅜" to 7". Change to a different size of slips or dogs is easily and quickly made.

QUICKLY INSTALLED WITHOUT INTERRUPTING DRILLING: MISSION Power Slips are quickly installed without interrupting or interfering with drilling operations. Operating post is bolted to a foundation beam and compressed air connection made. Operates on 2½ cu. ft. of free air per minute, but 4 cu. ft. compressor recommended to allow for wear.

ELIMINATION OF WEAR: When pipe is spinning, slips are not in contact with lifting ring, eliminating wear on rollers.

SIMPLICITY OF DESIGN, best materials, few parts, and accessibility insure trouble-free operation.

MISSION GUARANTEES proper mechanical performance, materials and workmanship. Before you buy power slips, insist on seeing the MISSION "Super-Speed!"

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water inlets or bays with natural shelter.

The existing deep-water ports of the eastern Mediterranean are Alexandria, Port Said, Jaffa, Haifa, Beirut, and Tripoli. All except Jaffa and Tripoli have anchorage sheltered by break waters, Port Said being sheltered by the jetties at the north entrance to the Suez Canal. Docks, wharves, and other harbor facilities are of minor consequence except at the Alexandria and Port Said naval bases. At Jaffa and Tripoli, all cargo is lightered to vessels anchored in the open sea about one-half-mile offshore.

At Haifa, refined oils are loaded over a pier sheltered by the break water, but crude is loaded through Iraq Petroleum Company's Acre Bay submarine lines to berths about 3000 feet offshore in eight fathoms of water.

At Beirut, there are no crude oil loading facilities. Occasionally bulk cargoes of refined oil are unloaded through relatively short submarine lines in St. Georges Bay, where tankers anchor outside the break water in five or six fathoms of water.

At Tripoli, refined oils are loaded through submarine lines at the Iraq Petroleum Company's loading berths, the characteristics of which are similar to the Acre Bay crude oil loading berths.

Elsewhere the east Mediterranean shore line is relatively straight. Charts indicate that outward from the shore depths of water increase uniformly, the eight- and ten-fathom curves being parallel to, and respectively, 3000 and 4000 feet from shore.

Meteorological records indicate that, except for a few days during two winter months, gales and storms on the east Mediterranean coast are not severe enough to interfere with coastal navigation. Based on these records, Trans-Arabian Pipe Line Company plans to construct at its Sidon terminal a concrete pier to berths for loading tankers in six fathoms of water about 2000 feet from shore line.

Sidon terminal will have twenty 180,000-barrel floating roof tanks, located on ground high enough to permit gravity loading of 20,000 barrel per hour and a maximum "turnaround" time of 12 hours per tanker.

Other Construction Features

The primary purpose of this paper is to mention unusual features applicable to the Trans-Arabian and other large-diameter Middle East pipe lines.

In the Middle East, it is necessary to procure "conventions" or pipe line transit privileges from two or more countries, including the lawful right to expropriate easements across privately owned lands. This may require months, and possibly a year or more.

Recruitment of experienced and skilled personnel—providing comfortable camp, housing, hospital, recreational, and subsistence facilities, as well as the procurement of passports, immunizations against communicable diseases, transportation for personnel and baggage almost half-way around the world—and other incidental needs of some 1500 to 2000 American personnel to be employed on the Trans-Arabian job, is a tremendous task.

Multitude of Details

Purchasing some 400,000 tons of camp equipment, supplies, construction machinery, tools, pipe, building materials, food, and the thousands of other items needed for the work—most of which can be supplied only from sources within the U. S.—requires experts in purchasing and shipping to foreign countries.

Contracting for marine transportation of the commodities mentioned in the foregoing paragraph, with shipping schedules timed to construction schedules and promised deliveries of materials at several U. S. Atlantic, Gulf, and Pacific ports, is also a big job. Trans-Arabian Pipe Line Company's shipping contract is reported to be the largest private peacetime marine shipping contract undertaken.

Arrangements for insurance and banking in Middle East countries having meager domestic insurance and banking facilities, or none at all, and customarily exchanging their currencies only with European countries, involve many complexities.

Trans-Arabian Pipe Line Company is confronted with the necessity of developing from scratch a Persian Gulf discharge port 150 miles from the nearest habitation. In many respects, this will be similar to measures adopted during World War II in so-called beach-head invasions.

At Ras Mishaab, the material-unloading port being developed on the Persian Gulf, vessels will discharge cargo into lighters or on an isolated wharf in the open gulf, 2½ miles from shore, where water is deep enough. An aerial steel cable way mounted 80 feet above the shallow water on timber "A" frame supports, 700 feet spans, is being erected between the isolated wharf and the material-storage and -assembly yard on shore. A recently developed gasoline-engine-driven conveyor, called a "skyhook" equipped with ten-ton hoisting winches and suspended on sheave wheels which run on the cables, will convey cargo from the isolated wharf to the material-storage yard.

Existing peacetime federal regulations require the procurement of export licenses for steel, iron, and copper goods, certain building materials, and other scarce commodities. The Office of International Trade is understaffed. Consequently, applicants for export licenses are burdened with severe penalties incident to delays in clearances. Domestic applicants do not object to the regulations, but do object to the costly penalties resulting from delayed clearances of applications.

An adequate supply of water along its entire route must be developed. Seven test water wells were drilled a year ago, and it is hoped that some 30 wells now being drilled will eliminate the necessity of trucking water prohibitive distances of 100 miles or more.

Subsistence, comfort, and medical care of construction personnel at the peak of activities, including 2000 skilled Americans and perhaps 5000 semi-skilled Europeans and Arabs, will require two staging camps; two base camps, each with hospitals, warehouses, shops, material-handling and -forwarding facilities; four portable pipe line construction camps; and 25 smaller intermediate way-station and pump-station construction camps.

The long overland truck hauling of pipe, construction materials, and supplies—involving a maximum of about 500 miles and an average of about 250 miles—is a job equivalent to the trucking of 400,000 tons of miscellaneous freight during the hottest summer months over unimproved trails the same distance across the Mojave Desert. This will employ a fleet of 150 six-by-six truck tractors, with a capacity of ten tons or over (majority 20 to 25 tons); 110 six-by-four trucks and truck tractors, with a capacity of 4½ to ten tons; 135 four-by-four trucks, with a capacity of 1½ to 4½ tons; 300 eight-wheel ten- to 25-ton dollies and trailers; and 200 four- and eight-wheel trailers, with a capacity of ten tons or less.

Additional Vehicles

Other rubber-tired vehicles to be used on the Trans-Arabian job will include 300 pickups and jeeps; 50 station wagons and light-weight five-passenger cars; 2 thirty-passenger buses; 10 forty-passenger trailer buses; 80 eight-hundred-cubic-foot reefers for chilled and frozen foods; 12 thirty-man lunch-serving trailers; 60 four-thousand-gallon gasoline and water-tank trailers; 10 eight-yard carryalls; 12 mobile auto service and greasing units; and 6 mobile machine shops for equipment repairs, etc.

Heavy construction equipment and machinery to be employed on the job will include 120 D-7 and D-8 tractors with various attachments; 10 twenty-five-ton crane trucks; 4 twenty-ton crane wagons; 20 motor road graders; 2 eight-ton road rollers; 7 No. 48 ditching machines; 30 fifteen-ton crawler cranes with buckets, hose, and other attach-

ments; 50 two-hundred- and three-hundred-cubic-foot air compressors; 110 two-hundred- and three-hundred-ampere gasoline-engine-driven electric welders; 6 rock crushers; 36 acetylene-gas generators; 8 power-driven pipe-cleaning and -priming machines; 6 power-driven pipe-coating and -wrapping machines; 30 mobile asphalt kettles; several heavy-duty rooters, pipe-bending machines, and concrete mixers; 2 pipe drivers; 2 one-thousand-horsepower steam tugs; 2 two-hundred-and-fifty-horsepower diesel tow boats; 2 one-hundred-and-sixty-five horsepower diesel utility boats; 4 five-thousand-barrel gasoline and diesel-fuel barges; and 8 eight-hundred- to one-thousand-ton lighters.

It is estimated that the following quantities of petroleum products will be consumed on the Trans-Arabian pipe-line construction job:

35 million gallons of gasoline
7 million gallons of diesel fuel
600,000 gallons of kerosine
900,000 gallons of lubricating oils
2 million pounds of grease lubricants
10,000 tons of asphalt

There is a shortage of unskilled workers in Saudi Arabia which will necessitate importation of workers from Egyptian-Sudan or other countries. However, at present, there are surpluses in Trans-Jordan, Syria, and Lebanon. Trans-Arabian Pipe Line Company received in Beirut 9600 written applications for employment in a three-months' period. The convention with each country traversed obligates the company and the company's contractors to give preference to the employment of available local unskilled labor and qualified resident skilled workers in each respective country.

Another major problem is the procurement of food for construction personnel. Most meats, vegetables, fruits and dairy products for personnel in Lebanon, Syria, and Trans-Jordan can be procured locally. But flour, canned goods, sugar, coffee, cooking oils, and staples for local workers, such as lentils, wheat, sugar, rice ,and coffee, will have to be imported from Argentina, South Africa, or Australia during the current food shortage in the U. S. All food for foreign and local workers in Saudi Arabia must be imported from other countries. It is estimated that workers on the Trans-Arabian pipe line job will require the importation of an average of 125 tons of food monthly.

Air freight, express, and passenger service will be supplied by Arabian American Oil Company with its fleet of two DC-4's, ten C-47's, an approximately as many smaller aircraft. Landing strips will be constructed at intervals of 50 to 100 miles along the pipe line route, with facilities at several intermediate landing fields for refueling.

Some essential items are difficult to obtain in the Middle East or in any other part of the world. Typewriters with numerals and letters in Arabic can be obtained only occasionally in Italy or Egypt, priced at about ten times the current price of new U. S. typewriters with conventional roman numerals and letters. Shoes manufactured in the Middle East will not endure hard wear or usage. Because of the peculiar shape of the Arab foot, he cannot comfortably wear a shoe made from a standard European or American last. Hence, the company must contract for the manufacture of shoes on special Arab lasts to accommodate the needs of its Arab workers.

To avoid complications and the filing of labor discrimination complaints with government authorities in some Middle East countries, an employer must maintain an accurate current record of the number of employes listed as acknowledged adherents to each particular religious sect or creed having representation in that particular country, and see to it that the number of employes of each sect bears about the same ratio to the total number of employes as the listed adherents of each sect bears to that country's total population.

Good Workers

Pipe line and other construction foremen who previously supervised similar jobs in Latin-American countries report that, in spite of the wide difference between Oriental and Occidental customs, thinking, religion, etc., and the impossibility of literal translations of many English words into Arabic words, Arab workmen learn skills readily and perform tasks cheerfully.

Attempts to translate English into Arabic, or vice versa, by employing an Arabic-English dictionary, frequently reveal certain Oriental traits and a well developed sense of humor, as may be observed from the following exact copy of a typewritten letter received from an applicant who convinced the writer of this that he should be hired:

"BEIRUT, DEKWANY, LEBAN,
"20, June 1947.

"*To the Manager of trans-arabian pipe line company*:

"DEAR SIR:

"I have the honour to ask your undistinguished inestimable nobility for the largest overpaid of two equally indistinguishable jobs, which I am able to do in good conditions, are: storekeeper and clerk, also it following them very soon the typewriting job which you will see in this letter I may do with much lack of impatience and many exactitudes: to act up to your advantageous activity in actualizing a useful business career like your excellency may not have hitherto experienced, as you perceive I am ready to my utmost in urging forward every possibility to stimulate (Mutatis Mutandis), especially toward every musty purpose against the thrift of its disposal and likewise so also I am willing to immediately receive every improvisional reconcilement to my application if is required and to affirm my education and conduct on some inconvenient opportunity to the authorized persons in your society to win merited honour in conforming an avocation in it.

"I hope to take my respectful demand this to the accession into consideration and not come to invalid inference, ultimately, in recognition to your restorative undertaking to every musty purpose, it now comprehend my attainment to the attentiveness to your obedient servant—

"(signed) ELIAS MHANNA

"Individual observations and its following:

"Educated in elementary schools during the infancy, then I went to extremes during the night ones education, eventually, I had a prosperity over the environment of a business career for self efficiency as honest shopkeeper during three years and now I am at the promising outlook for job as I am in a monotonous penniless dreariness—

Nationality: Lebanese
Birthplace: Kafertin
Building: Bshara Mhanna
Birthdate: 1927 B. C.
Livingplace: Dekwany
Languages: Arabic, French, English unexcelled speaking, reading, writing, and arithmetic.
Typewriting: Much possibility doing 30 words leisurely or 42 words some minutes if pressed.

Applying for your expected excuse why your noble inestimable company cannot right now employ another efficient servant —obediently.

"ELIAS MHANNA."

Iraq Petroleum Resumes Drilling on Large Scale

Following the enforced hiatus of the war years, Iraq Petroleum Company and associates have resumed exploratory activity on a large scale.

Lebanon Petroleum Company's Terbo 1, situated five miles east of Tripoli, was commenced on May 7, and is drilling below 3000 feet.

Much of the drilling equipment used at this well is of British manufacture and is capable of drilling to more than 10,000 feet. Drilling is of an exploratory nature. The site is in the hills overlooking the Mediterranean, just north of Tripoli.

Syria Petroleum Company's Bafloun 1, 30 miles north of Aleppo, also is drilling below 3000 feet, and further tests are planned at Dolaa before the end of this year and at Abba in 1948.

In Palestine, Petroleum Development (Palestine) Ltd. spudded in Huleiqat 1 near Gaza at the end of September, and a further test is planned at Kurnub, 40 miles southeast of Beersheba early in 1948.

These wells are being drilled with the first British-built rigs of this type to be put into operation.

Basrah Petroleum Company plans tests at Nahr Umr and Zubair in Iraq in 1948, and exploitation activities of other members of the I.P.C. group include the resumption of development of the Dukhan field in the Qatar peninsula.

Charles Lockett to Head Middle East Pipelines

CHARLES LOCKETT of Standard Oil Company (N.J.) will become president of Middle East Pipelines, Ltd., with Anglo-Iranian Oil Company holding 50 percent interest in the company, Jersey Standard 30 percent, and Socony- Vacuum Oil Company, 20 percent, according to reports from London. Prior to the actual formation of Middle East Pipelines, as this issue of WORLD OIL goes to press, it was reported that the company would be governed by a board of six directors, 3 of whom will be Americans, 2 from Jersey and 1 from Socony, and 3 of whom will be Anglo-Iranian personnel.

Middle East Pipelines will be the operating concern for the new 34-36-inch line projected from the Anglo-Iranian fields at the head of the Persian Gulf to the Eastern Mediterranean seaboard. The line will start north of Abadan and probably will terminate on the Syrian coast some here in the 100-mile stretch between the ports of Latakia and Tripoli. Good harbors exist at both of these towns, but there are no port facilities between them. If the line should run to Tortosa, one considered terminal, 40 miles north of Tripoli, complete harbor installations would have to be made.

The northern Syrian coast terminal would mean an 800-mile route for the line across Iraq and Syria. The company plans to begin negotiations with Syria before Christmas for transit rights, but if serious difficulties arise in the parleys, several top Middle East officials are said to favor switching the route south of Syria through Trans-Jordan into Lebanon or Palestine.

It is not likely that the line will be completed before 1951 since the pipe will not be rolled in the U. S. mills until after completion of the order for Trans-Arabian Pipeline's new 30-31-inch line from Saudi Arabia to Sidon, Lebanon. The Middle East carrier will have a capacity somewhat in excess of 500,000 barrels daily.

Anglo-Iranian is scheduling a large-scale expansion program for the next five years in production, refining and transportation. One company official said an active production plan would be pushed, although the Persian Gulf fields were already virtually drilled up for the new line. The Abadan refinery is being extended for the production of lubricants and by the addition of a "cat" cracker and increased storage capacity. The A-I tanker fleet now numbers about 100 bottoms.

Charles L. Lockett

Relations of Anglo-Iranian with the government of Iran are still doubtful in some respects. The recent conflict with Russia and the cancellation of the previously negotiated Russian contract in the northern provinces, have led Iran to a highly nationalistic position. The Iranian deputy premier first called on his nation to exclude all foreign petroleum operators. Premier Ahmad Ghavam, who just two years ago signed the agreement with Russia—a pact which was later repudiated by his own Parliament—has proposed a substitute measure which would prevent further concessions being granted to any foreign power and asks a renegotiation with Anglo-Iranian for higher royalties. Anglo-Iranian paid Iran $20 million last year, an amount that represented 12 percent of the Iranian government's total income for 1946.

Since the repudiation of the Russian concession, a new Iranian oil company, wholly national, has been formed. It is not believed that this action necessarily prejudices A-I's position, since the currently existing contract which the company holds has written in it a clause preventing the cancellation of the company's concession. However, the company's payments could be radically scaled upward, and it is known that Iran has mapped some plan by which the government's "take" would be proportioned to the profits of the company rather than to a strictly production basis.

Iran Production Up

Production reports from Anglo-Iranian Oil Company, Ltd., indicate a continual increase of production with the progression of the year. Production for Iran in August was 2,056,000 tons, or 15,543,360 barrels. Total production for the eight months of January to August was 13,365,000 tons, or 101,039,400 barrels.

Anglo-Iranian Builds Line

Anglo-Iranian Oil Company, Ltd., is laying a pipe line from the new Lali field, 20 miles northwest of Masjid-i-Sulaiman field, which is expected to be completed near the end of 1947. The new line will tie into the crude lines running to the Abadan refinery. Lali field was discovered in 1945 and is now being developed.

Iran Rejects Soviet Oil Pact

The Iranian Majlis (Parliament) rejected on October 22 an agreement negotiated with the Soviet government in April, 1946, for oil concession and exploration rights in north Iran and substituted a five-year plan to explore for oil which would bar all foreign capital. This means that the Iranian government will undertake to explore for oil, and that all concessions to foreigners for oil production or the creation of companies with foreign participation for such purposes are now illegal. The bill further provides that if oil is found in Iran under this five-year program the government may negotiate with Russia as a purchaser of the oil. It further specified that Iran would negotiate with Anglo-Iranian Oil Company, which now holds the only producing fields in the country, to obtain a larger share of its profits. Specifically rejected was a tentative pact signed by Premier Ghavam last year to give the U.S.S.R. a 51 percent share in a Soviet-Iranian oil company. Anglo-Iranian's concession, negotiated in 1933, is valid until 1993.

Following announcement of the bill the Iranian Parliament was informed that a native company, The Levantour Company, at Teheran, was able to organize with a capitalization of approximtely $32 million for development of, and search for, petroleum.

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Attention Mr. William Brewster

Dear Mr. Brewster:

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This is due to the very excellent packing and crating that has been given this property while in your hands for export. Our surveyor rendered a most attractive report and in his opinion, the packing conditions couldn't be improved upon. Not only were you using brand new packing material in your cases, steel strapped and lined with water-proofing material on the inside, but he found the airplane itself pretty well moisture proofed and found the plane securely anchored to prevent it from moving either horizontally or vertically inside the crate.

The packing employed by your concern is more the exception rather than the rule and it is for this reason that we felt disposed to write your cargo business at such attractive rates.

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Discovery Highlights Activity in Canada

By C. O. NICKLE
Staff Writer

CALIFORNIA-STANDARD Company and Imperial Oil, Ltd., have made a joint oil discovery of importance on the Southern Alberta Plains; an independent syndicate has made a gas discovery and a possible "heavy crude" discovery in Central East Alberta; the Leduc oil field has been doubled in area; and Continental Oil Company has started a large-scale program in Alberta.

The past month has been a period of good news for Western Canada's oil industry.

California-Standard and Imperial Oil delivered a joint discovery November 3 at Cal-Imperial-Bantry 11-2-18-13, SE lsd 1 2-18-13w4th, about 100 miles east and south of Calgary, and ten miles southwest of the South Princess Madison lime oil field. On the basis of drillstem tests, the discovery could well be the best oil well yet completed on the Alberta Plains outside of the Leduc field.

The discovery zone is a Basal Cretaceous sand at 3243-59 feet, bearing natural gas in large volume plus oil in the upper portion; a little gas and a considerable volume of clean 24-gravity API oil in the lower portion. The sand is underlain by a shale break, and a tight, dry chert zone, which overlies the Madison limestone. Staked on a seismic high, the well was planned as a test of all horizons to the Devonian, is now going on for a test of the deeper sections to the Devonian.

Gas Strike Made

The St. Paul syndicate, financed by independent oil operators and business men of St. Paul in East Central Alberta, has made a shallow natural gas discovery and indicated a new discovery of heavy crude at two wildcats drilled the past month one-half mile southeast of the town. The strikes were made in the Colony sand at the top of the Lower Cretaceous. A pipe line is being laid to connect the No. 1 well with industrial consumers in St. Paul (population: 2000). It is planned to extend service to domestic consumers in 1948.

Leduc's Area Doubled

The Leduc field, discovered by Imperial Oil last February, has had its proven area doubled (to about 6000 acres) by the successful completion of Globe-Leduc West 1, lsd 6 19-50-26w4th, 2½ miles due west of the former proven limits. This well, backed by two independent companies, obtained a flush flow of around 700 barrels daily of 41 API gravity oil at 5064-100 feet. The productive horizon is the D2 zone of the Devonian.

The reserve of the Leduc field is now estimated by Imperial at a minimum of 50 million barrels, a maximum of 100 million barrels. On November 10, the field had 23 assured oil wells, including 12 with commercial production in the upper or D2 zone of the Devonian (of which two are deepening for the lower zone) and 11 producing from the lower or D3 zone of the Devonian.

The field was extended three-fourths mile farther south in mid-November by East Leduc South Brazeau 1. D3 zone Devonian was topped at 5403 feet and a test at 5412 yielded 700 Mcf of gas plus oil flow at surface in 15 minutes. The well had an estimated 1000-plus barrel potential.

Acreage in the Leduc area is obtaining highest prices. Atlantic Oil, Ltd., paid $1250 per acre for 160 acres between two Devonian producers of Imperial Oil.

Refinery Being Moved

Imperial Oil Company, Ltd., is proceeding with dismantling and reconstruction of the Whitehorse refinery on its new Edmonton, Alberta, site, where it will process crude from the expanding Leduc field to the south. The refinery will handle 10,000 to 12,000 barrels per day of Leduc crude, which will be delivered by railroad until a pipe line can be built to connect with the line to Nisku on the railroad below Edmonton.

Continental Enters Play

Continental Oil Company, which did some exploratory drilling in Alberta 20 years ago as Marland Oil & Gas Company, has decided to reenter that province with a large-scale program. It is operating in Alberta under the name of Hudson's Bay Oil & Gas Company, Ltd. (of which it is a joint owner, with Hudson's Bay Company, of several million acres of widely scattered oil rights in Alberta and Saskatchewan).

Conoco has completed an agreement with Husky Oil & Refining, Ltd., for joint exploration of 115,000 acres in the Lloydminster region. Five widely-spaced wildcats have so far completed in this project, with four obtaining sufficient encouragement in Lower Cretaceous sand to warrant setting pipe. These four are now on test, and at least two may rate as oil discoveries. Three more wildcats are now starting.

On its own Conoco has acquired 392,000 acres of crown oil and gas reservation in a 75-mile long belt starting about 30 miles north of Calgary, and extending 20 miles northwest of Red Deer. The block is virgin territory, along the southerly part of the "Alberta Basin," source of Leduc's discovery. Gravitymeter work has been started on the block, with seismograph work expected to start in the spring.

Southwestern Venezuela Test Has Showings at 9763 Feet

A wildcat being drilled by Socony-Vacuum Oil Company of Venezuela on its concession in the state of Barinas, Southwestern Venezuela, found some showings of oil and was still testing at 9763 feet.

The well, Silvestre 2, on the Santos Domingo River, 30 kilometers south of the town of Barinas and ten kilometers southwest of Silvestre 1 just off the river, was bottomed at 9766 feet, with casing cemented at 9259 feet. Testing has been hampered by mechanical difficulties, according to a company report. The well pressures were below normal, according to the report. Additional exploratory drilling is planned to evaluate the discovery. The company has drilled five dry holes on the concession.

Sun Oil Company Abandons Oil Search in Nova Scotia

Sun Oil Company has abandoned its search for oil in Nova Scotia. After two years, the company shut down its last test at Nappan, near Amherst, at 11,504 feet. In the first attempt at Nappan the drill broke at 6000 feet and the hole was junked at 6499 feet. Operations in the area are estimated to have cost Sun $1 million.

The company has also test drilled in other sectors of Nova Scotia for the past 15 years, mostly on the western shore of Cape Breton Island, without discovery of commercial production.

Eliminate *'one-man'* opinions

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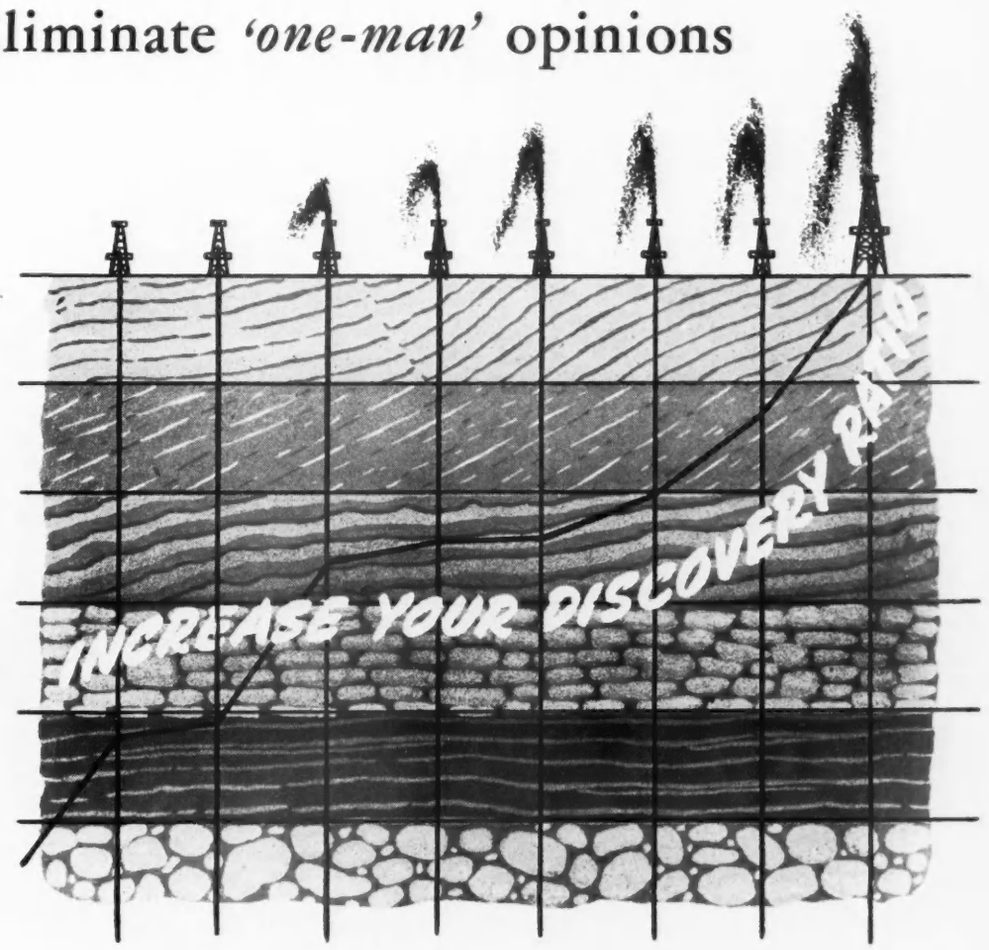

'ONE-MAN' opinions can prove costly in exploration work. That's why *many* competent interpreters are used to check data obtained by Garrett Exploration Company. 'One-Man' opinions have been eliminated. Thus Garret has increased its discovery ratio. The record shows that 67.6% of all exploratory tests drilled in locations indicated as favorable prior to drilling have developed commercial production. An additional 21.2% of such tests have confirmed Garrett's prediction as to favorable structural position. This outstanding achievement is a direct result of thorough examination and re-examination of data. The personnel and equipment of each field crew are carefully selected to obtain the maximum rate of coverage. The resulting efficiency and economy of Garrett Exploration Service make it particularly desirable for contract work. Write for full information.

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Peruvian Government Issues Blast At Critics of Sechura Desert Contract

The Peruvian government last month issued a counter-blast at critics who, it is charged, have turned the "Sechura Desert Contract" for oil exploration into a political football.

The contract is a proposal by International Petroleum Company to explore the oil resources of the Sechura Desert, south of the present producing fields in Northern Peru. Though the possibility of finding commercial oil deposits in this area has been explored and turned down in the past by the Shell interests, Phillips Petroleum Company and by International (subsidiary of Seaboard Oil Company of Delaware), it was believed when the contract was formulated that more modern methods of exploration might make exploration in this area successful.

The government's answer to critics stretches over 19 typewritten pages and contains a sweeping denial to 16 objections to the contract raised by the political opposition.

The government sets forth in part:

No political maneuver, the contract "was discussed and written by Engineer Enrique Gongora, who is notoriously free from any political affiliation . . . "

The contract is not an attempt to make political headway by balancing the budget. The income from the contract, which was passed by the Chamber of Deputies in 1946 and now awaits Senate approval, represents only 2.6 percent of the 1948 budget estimate.

The contract does not represent an attempt to "alienate" the six provinces containing the concession. The government will bear no part of the cost of exploration.

Far from stripping the government of control over the area, the contract makes the government the principal partner.

Had not foreign capital been admitted to Sechura, the region might never have been properly explored. Between 1922 and 1929 there existed up to 113 concessions and nothing was done. "The contract therefore does not exclude all possibility to Peruvians; it only brings to an end a cycle of offers and concessions which have given no results . . . "

Contrary to the opposition's charges, Sechura has yet to prove itself "the best and richest known oil field which Peru possesses." This must be proven by exploration, and nobody in Peru has come forward with adequate capital to do the job.

The exploration work will aid the Peruvian oil industry as a whole in that 80 percent of the technicians and other workers must be of Peruvian nationality, paid the same salaries as foreign personnel.

Brazil's New Producing Area Accorded Good Possibilities

A new producing area in Brazil's state of Bahia, north of Salvador, is accorded good possibilities of production. Its August rating was nearly 1000 barrels of crude from the two wells in the field.

Brazil's August crude production report was 8789 barrels, a slight gain over July's total of 5892 barrels, but September output was down to 4757 barrels. Candeias field was responsible both for the gain and the decline, its eight wells in August producing 6694 barrels and seven wells in September producing 3542 barrels. Production fluctuated widely in the Lobato-Joanes field, which in July reported two wells producing 70 barrels, in August 1037 barrels, and in September 751 barrels. The new Dom Joao field had only one well, producing 325 barrels, in the September total.

Colombia Lease Abandoned

Tubará Oil Company (International Petroleum Company and Socony-Vacuum Oil Company) of Colombia has abandoned two wildcats and surrendered its lease, private oil rights to which were recognized through a Supreme Court decision of October, 1942.

U.S.S.R. Production Gains 21 Percent

A U.S.S.R. official report for the third quarter of 1947 indicates that the oil trust increased production by 21 percent as compared with a similar period in 1946.

The State Planning Commission announced that the Southern and Western regions had fulfilled 107 percent and the Eastern region 114 percent of their quotas during this period.

Colombia Products Line May Be Completed This Year

Tropical Oil Company expects the completion this year of its new six-inch products pipe line in Colombia running from Barrancabermeja to Puerto Berrio. Work on the 125-mile line is progressing rapidly, with nearly 100 miles already laid.

The line will have a capacity of 7200 barrels per day, and is designed to insure a constant supply of products to industrial plants in Antioquia and other interior regions during periods of low water on the Magdalena River when shipping is hindered.

The Antioquia Railroad, which is owned by the district government, private industries in the state, and Tropical Oil Company, is reported to have completed plans for continuing the line from Puerto Berrio to Medellin, important industrial city of Antioquia. The 107-mile line will be designed to transport both crude and refined products.

Italian-American Company Approved

The Italian treasury gave its consent to formation of an Italian-American oil company, with Standard Oil Company (N. J.) and Azienda Nazionale Idrogenazione Combustibili each owning 50 percent of the stock. The Italian government owns 50 percent of ANIC share capital and the other half is owned by the Montecatini group. Previously, the treasury had refused to ratify a plan advanced by Standard, which would have given that company 51 percent of the stock. This is the second international oil company to be formed this year, a British firm having joined Azienda Generale Italiana Petroli (AGIP) on a 49-51 percent basis.

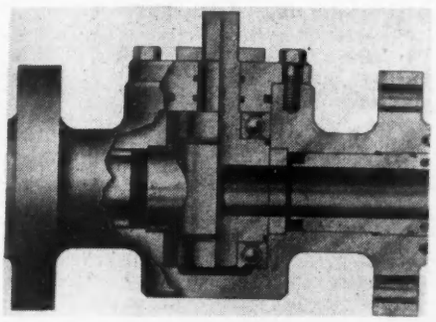
Standard's contribution will be the capital necessary for reconstruction and enlarging of the Leghorn refinery. Plans for the refinery and hydrogenation plant include its expansion from its prewar capacity of 2,295,000 barrels per year to 11,505,000 barrels annually. The works were destroyed by the Germans and all equipment taken into Germany. The new refinery will have a full cracking plant and is to be one of the largest and most efficient in Italy. The Italian government hopes in some measure thereby to compensate for the loss of the refineries at Fiume (Yugoslavia) and Trieste (Free Territory). Subsequently, the ANIC refinery at Bari will be modernized and enlarged.

Most of the supplies for the Leghorn refinery will come from the Middle East, and sales of the products will not be limited to Italy but will supply the Mediterranean zone. The Italian sales organization of Standard will handle the marketing. The government hopes the Leghorn refinery will thus become a most important center of oil processing and distributing.

NEW EQUIPMENT and Literature

1—Non-Lubricated Plug Valve

A quick-opening, high pressure fluid control valve, known as the "LJS Plug Valve" is now in production. LJS valves feature a straight, non-tapered plug that requires no lubrication and is suspended



top and bottom on sealed ball bearings which takes the thrust radially. This plug is the only moving part. A quarter turn opens and closes valve at high pressures and temperatures, requiring very little torque.

"Floating" seats of hardened steel are ground and lapped for a precision fit with plug for perfect seal at each port. Plug does not touch body at any point, keeping friction to a minimum. Behind each seat, an expansion gland forces seat tightly against plug with just enough "give" to prevent plug from seizing or sticking. These glands are held in place by replaceable steel retainer sleeves. At no time does fluid ever come in contact with valve body; wear can only result from longitudinal flow of fluids. All wearable parts (plug, seats, glands, sleeves) may be replaced right on the job without use of special tools.

Straight line flow offers no restrictions, creates no turbulence and effectively resists corrosion, heat, abrasion and product contamination. Flange and screw type LJS plug valves are available in ferrous, non-ferrous and special metals for every type of industrial use.

For additional information write Johnson Foundry and Machine Company, 1119 North Main Street, Los Angeles 12.

2—Foam System

A blanket of fire extinguishing foam approximately six inches deep over the entire pump house and manifold pit area now can be laid in less than three minutes, according to the manufacturers, by a complete fire-protection system employing Aer-o-foam. The foam system can be operated manually or, in cases where an attendant is not always on duty, mechanical operation is possible.

In the pump room, the foam is delivered through overhead spray nozzles so as to cover the tops and sides of all pumps and other machinery in the room, as well as the floor area around the units. In the manifold pit, the foam is introduced through floor deflectors, as any fire in this area would be at the level of, or under the piping. A storage tank containing 80 gallons of Aer-o-foam liquid and a rotary pump with a capacity of 29 gallons of foam liquid per minute are provided; however, size and local conditions dictate the method and size of foam system. The pump takes suction from the liquid storage tank and discharges directly into the water stream, which is at a rate of 454 gallons per minute at 100 pounds pressure. The resulting fire-extinguishing solution of 483 gallons per minute consists of water and foam liquid, providing a 6 percent solution which is discharged at the many nozzle outlets spaced to give coverage over the entire protected area.

Since there is no foam formed until the discharge outlet is reached, where air is entrained (ten gallons of foam per gallon of water), the lines may be small. And, as each discharge outlet acts

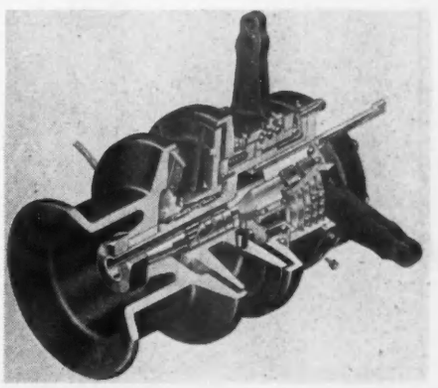
as a meter, there need be no complicated calculations of pipe sizes to assure equal distribution.

For additional information write the National Foam System, Inc., 1400 Packard Building, Philadelphia 2.

3—Friction Cathead

The Simplo-friction cathead, made in both makeup and breakout types, have given satisfactory performance in shop and field tests. The activating mechanism is a simple ball-bearing thread unit located adjacent to the drawworks. They are compact, extending only 25 inches from the drawworks in most installations, and thus reducing the possibility of bending or kinking the shaft.

Another outstanding feature is said to be the Simplo-friction non-adjusting activating mechanism which gives 95 percent clutch efficiency. They are comprised of a minimum number of parts, as indicated by the cutaway view shown,



the only expendable parts being the ball bearings. Supplied with full-size spools which permit plenty of large diameter wraps of catline, the new "American" Simplo-friction cathead is said to be simple in operation and quick to install. Speed of the jerk line is under control of the driller at all times, and no brakes are required to prevent the drum from crawling.

For additional information write American Iron & Machine Works Company, P. O. Box 1177, Oklahoma City.

4—Chemically Inert Gaskets

A chemically inert gasket, known as "Chemiseal" is a product of special techniques which impart resilient characteristics to thermoplastic materials. The gaskets are fabricated from teflon (polyletrafluoroethylene), which is fully resistant to the chemical action of organic and inorganic acids, bases, esters, ketones, aromatic hydrocarbons, halogenated solvents and acids. No known material, except melted sodium, and fluorine under pressure, reacts with them or causes any physical change. Temperatures ranging from —200° F. to +500° F. can be accommodated without brittleness or decomposition.

The anti-adhesive properties of Chemiseal gaskets are unique in that they never stick to flanges or become coated with process materials, greatly enhancing their value in product purity control, as well as eliminating equipment damage during replacement.

For additional information write, United States Gasket Company, 651 N. 10th Street, Camden, N. J.

5—Deadline Anchor

The trend to the use of long drilling lines prompted the development of the Deep Well Deadline Anchor Clamp designed to securely tie down the dead end of the rotary drilling line without

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DROP FORGED STEEL LIQUID LEVEL GAGES

Liquid always shows black—empty space shows white. Preferred where the liquid level must be easily and positively visible, and when liquids are under high pressure or at high temperature. Made of alloy temperature resisting steel and are highest quality throughout. Liquid chamber made from solid block of steel to assure perfect alignment and rigidity. Conform with A.P.I.—A.S.M.E. requirements.

The "Reflex" is one of the complete line of Penberthy Gages that meet every liquid level gage requirement.

PENBERTHY INJECTOR CO.

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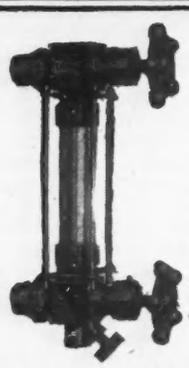
"ALL IRON"

LIQUID LEVEL GAGES



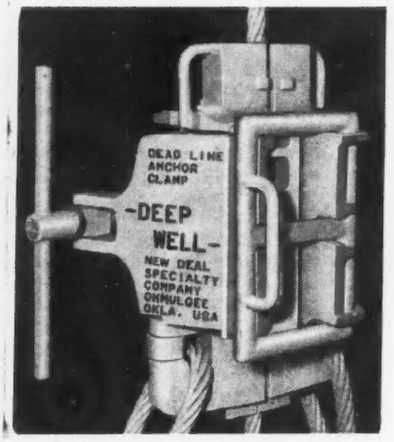
Body made from a special high strength alloy iron, shanks alloy steel and trim stainless steel. Extra heavy construction throughout, automatic and positive shut-off if glass breaks, heavy duty stuffing boxes. Conform with A.P.I.—A.S.M.E. requirements.

The "All Iron" is one of the complete line of Penberthy gages that meet every liquid level gage requirement.

PENBERTHY INJECTOR CO.

DETROIT, MICH. Canadian Plant WINDSOR, ONTARIO

distorting it, thus eliminating many wire line clips. An outstanding feature is the speed of operation when slipping the drilling line. It requires only one man a few second to loosen the clamp. After



the line is slipped to the desired position the man retightens the clamp in a few seconds.

The safety of the clamp has been proven by laboratory and field tests to have a gripping power beyond the rated strength of 1¼-inch drilling line. It may be used on any size of drilling line up to 1½-inch by merely changing the renewable liners.

The clamp weighs about 350 pounds and is built principally of electric cast steel and electric alloy steel. It is held in place by means of an endless loop cable placed under the derrick sill or "deadman."

For additional information write the New Deal Specialty Company, Okmulgee, Okla.

6—Swing Check Valves

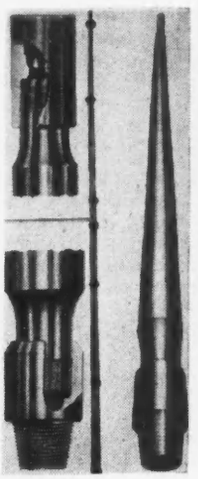
New swing check valves, known as the "3000" series are said to offer the advantages of sensitivity to low flow, full flow through the valve with minimum resistance, non-leaking through the

check, and a free-action check mechanism which will not stick on minimum flow.

These valves are available in both the screwed and flanged types, in bronze aluminum and gray iron, sizes ½ to six inches. Larger sizes will be available later.

For additional information write Pokorney Manufacturing Company, 3117 Clybourn Avenue, Chicago.

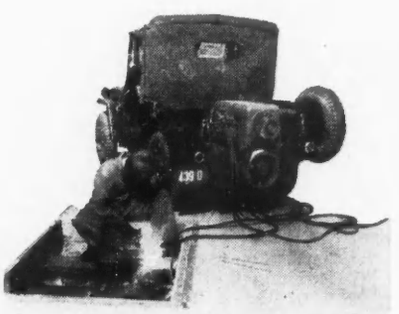
7—Drill Collars



The new Reed Super Shrink-Crip Tool Joints for drill collars make it possible to replace worn boxes and pins in the field and thus eliminates much of the time consumed in transportation and shop repair. Both tool joints, the box and pin, are attached to the drill collar by heating the tool joint and screwing it on by hand. When the tool joint threads become worn or damaged, the unit may be removed by reheating and unscrewing by hand.

Once the drill collar is threaded for the super shrink-grip connection, no rethreading of the drill collar becomes necessary when worn or damaged box or pin threads are to be replaced. The tool joints are factory made, thus providing uniform threads and dependable heat treatment. Factory-applied hard metal bands to resist wear can be supplied.

For additional information write Reed Roller Bit Company, Mack & Avenue Q, Houston.



8—Jeep-Mounted Welder

A new method of jeep-mounting an arc-welding generator has overcome certain objections to direct engine coupled welding generators. Direct drive meant that the Jeep engine had to be run at high speed, about 2800 revolutions per minute, for proper welder performance. This was too costly.

A standard P&H Model WG-200 welding generator was coupled to the rear power takeoff. Pulleys of the proper ratio permit the Jeep engine to operate at approximately 1500 rpm. This speed also enables the welding generator to operate at peak efficiency over its welding range, from minimum to maximum. V-belts are used in the hookup.

The welding generator is mounted for easy removal. Four bolts hold it in place, making it quick to replace the generator with an air compressor as the need requires.

For additional information write Harnischfeger Corporation, 4400 West National St., Milwaukee.

How one Louisiana producer STOPPED SURFACE FREEZING IN A HIGH-PRESSURE WELL

THERE was *plenty* of oil below the surface.

But the well would only make gas on a 1/8" surface choke with 3,000 pounds pressure!

Naturally, freezing of surface flow lines and connections was frequent . . . and severe. The allowable could not be produced.

Things looked pretty hopeless until a representative of OTIS PRESSURE CONTROL, INC., Dallas, Texas, was called in to discuss the problem. Upon his recommendation, an Otis Removable Bottom Hole Regulator was installed in the tube at 4,000 feet.

Then here's what happened:

Surface pressure dropped to 1350 psi. All freezing ended. The gas-oil ratio was cut to a point where almost no gas was wasted.

The regulator stayed in the tube 57 months, and produced 869,839 barrels of oil before it was pulled for inspection.

What was its condition? First-class. Because Otis Removable Bottom Hole Regulators are made of "K"* Monel!

This rugged Nickel Alloy resists the corrosive action of sour crudes; withstands stress, vibration and flow-cutting; serves dependably even in high-velocity wells that produce sand.

Heat-treated to develop its tensile strength to 145-170,000 psi, and its hardness to 25-35 Rockwell "C", "K" Monel brings long life and improved performance to many types of oil field equipment.

OTIS REMOVABLE BOTTOM HOLE REGULATOR adds surface-controlled rate of production to the advantages of bottom hole choking. Because of its "K" Monel construction, the regulator withstands the abrasive action of flow.

THESE ARE THE PARTS of the Otis Type B Removable Bottom Hole Regulator – all "K" Monel. Left to right: valve housing assembly, valve seat and spring assembly, regulator cage, mandrel assembly, complete regulator. *Photos courtesy of Otis Pressure Control, Inc., Dallas.*

Equip your well with

"K"* MONEL

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street, New York 5, N. Y.

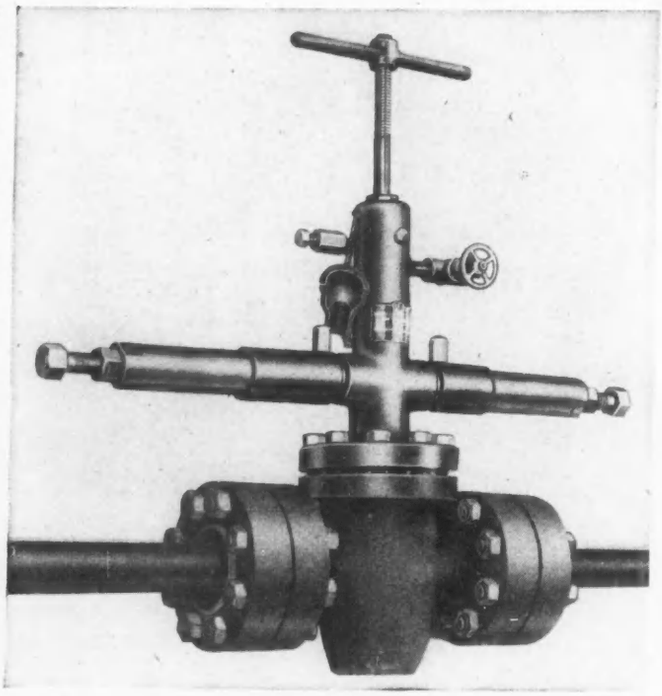
NICKEL (INCO TRADE MARK) **ALLOYS**

MONEL*• "K"* MONEL • "S"* MONEL • "R"* MONEL • "KR"* MONEL • INCONEL*• NICKEL • "L"* NICKEL • "Z"* NICKEL

*Reg. U. S. Pat. Off.

9—Surface Safety Valve

A new heavy-duty automatic surface safety valve has been designed to prevent line breaks caused by excessive pressure increase, or to shut off a broken line. It is a simply-constructed, self-contained, pressure-operated, full-opening gate valve which automatically closes when operating pressure goes above or below that for which the valve is set. Operating pressure can be supplied by the line in which the safety valve is installed, or it can be furnished through a connection to an outside source. When the valve is operated by line pressure, all connections are within the valve itself. When an external source of operating pressure is used, it is connected directly.

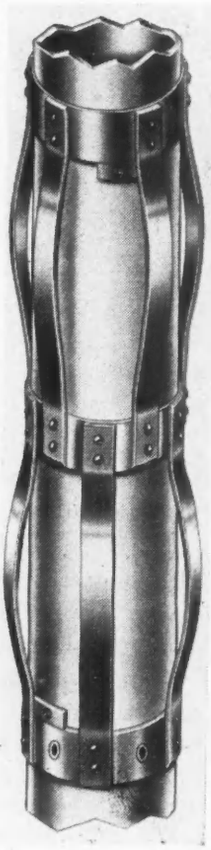


When the valve is open, operating pressure is applied to both sides of a piston. As long as this equalized condition exists, the valve remains open due to the upper end of the stem being exposed to atmosphere. However, when pressure beneath the piston is exhausted at atmosphere, full operating pressure is applied only against the top of the piston and instantly closes the valve. Pressure is exhausted from the cylinder beneath the piston through adjustable spring-loaded pilot valves.

Valve body and gate are of conventional design and are available in several makes, or types, in any standard size and test pressure.

For additional information write Otis Pressure Control, Inc., 6600 Denton Drive, Dallas.

10—Casing Centralizer



A completely new casing centralizer provides ten-point contact and increased peripheral bearing on the wall of the hole. According to the manufacturer, the centering strength of this centralizer is four times that of long stave types. This is due to the shorter arc of the centralizer springs which are said to have twice the strength of long stave centralizers that work as individual units.

The new centralizer is 33¾ inches long, and the individual staves are 1½ inches wide and 3/16-inch thick. The staves are cold riveted to the end rings and are staggered to provide the ten points of contact with the formations.

Easy installation on the pipe has been achieved by a design that permits plug-welding of lugs inside each end ring. During cementing operations, the casing may be rotated without rotating the casing centralizers, and thus prevent damage to the well bore and to the centralizer.

The method of installing these units on the pipe is such that the centralizers are always pulled through well bore restrictions instead of being pushed through. No on-the-job adjustments are required. The centralizers are manufactured in a great variety of sizes and can be furnished tailor-made for any size hole.

For additional information write Larkin Packer Company, Inc., St. Louis.

11—Wire Line Anchor

The National Supply Company and The Martin-Decker Corporation have collaborated in the development of a new combination wire line anchor and weight indicator, Type D. The wire line anchor is used to actuate a hydraulic pressure transformer, which in turn transmits pressure to operate the weight indicator.

The Ideal Type D wire line anchor and the Martin-Decker Type D weight indicator combine the elements of (1) the wheel (for anchoring the wire line) and (2) the lever for measuring the load on the wire line. A gauge at the driller's position registers the force on the lever which is transmitted to the gauge through the hydraulic pressure unit.

The Type D anchor is furnished for use with wire line up to 1¼ inch diam-

Gotkool
WATER CANS
& COOLERS
GOTT Water Cans are the practical way to keep drinking water cool for long periods, protected from impurities and always handy to the job. Snug fitting large removable top, strongly built to withstand rough usage. GOTT Water Coolers have extra large covers and a handy non-leaking push button faucet. Your Supply Store has them, get one today! . . . . . .
Gott
WATER CAN
GOTKOOL WATER CAN
Made in 1½, 2, 3, 5, 10, 15 and 20 gallon sizes. (Push-Button Faucet at slight additional cost.)
Gott
GOTKOOL WATER COOLER
Made in 2, 3, 5, 8, 10, 15 and 20 gallon sizes with Push-Button Faucet
H. P. GOTT MFG. CO.
WINFIELD, KANSAS
KEEP PURE DRINKING WATER ALWAYS HANDY

Why you, your advertising manager, and advertising agency are partners

FROM WHERE YOU SIT, advertising may look like the "glamour department" of your company—necessary, of course, but pretty far removed from the hard-headed realities of the production line.

But take a closer look. In one respect, the advertising manager's job bears a striking resemblance to your own.

You're production-minded. You're concerned with anything that will improve plant procedures, speed up assembly time, prevent waste, and reduce the manufacturing cost per unit.

And that is precisely where you walk arm-in-arm with your advertising manager and advertising agency. Because they think the same way about the *manufacture of a sale.*

The whole process of selling and distribution are their assembly line. And every time they can reduce the unit cost of a sale by so much as a few cents, it increases your company's chance to show a profit.

Ask them for a definition of advertising, and they will probably tell you that it is simply *mechanized selling*, a machine that multiplies the productive capacity of the sales force—seeking out prospects, arousing their interest, creating a preference for the things your company makes.

And when it is concentrated among the hand-picked readers of business papers, advertising becomes the most efficient machine these partners of yours have found for lowering the cost of producing a sale.

What are the ten ways to measure the results of your business paper advertising? You'll find the answers in a recent ABP folder, which we'll be glad to send you on request.

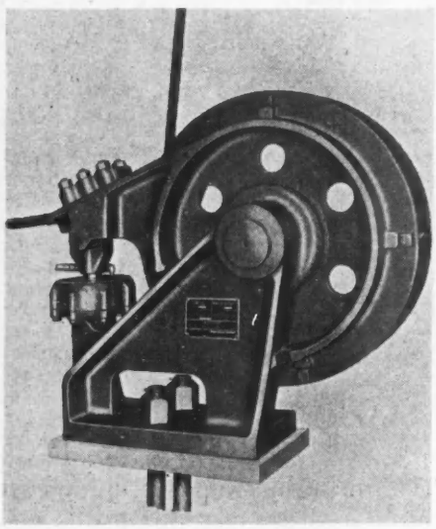
WORLD OIL

Specialized for the Drilling, Producing and Pipe Line Industry

WORLD OIL *is one of the 129 members of The Associated Business Papers, whose chief purpose is to maintain the highest standards of editorial helpfulness—for the benefit of reader and advertiser alike.*

eter. The Type E, a larger wire line anchor having greater load capacity with appropriate instrumentation is available for 1⅜-inch and 1½-inch wire line.

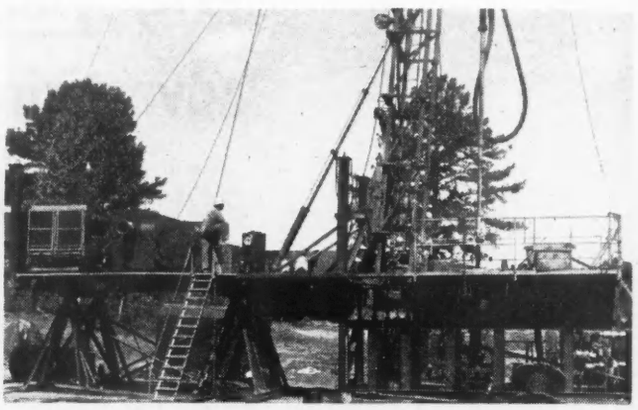
Both Type D and Type E combinations are said to provide safe, efficient, and economical line anchoring with accurate, sensitive and convenient weight control. Increased efficiency for these important drilling functions is thus achieved through simplified methods.



For additional information write The National Supply Company, Toledo 1, Ohio.

12—Hy-Lift Rams

The Rambler Rig can now be equipped with Hy-Lift Rams to elevate the entire rig to permit the placing of a substructure. Semi-trailer mounted Hydrair Hoist with the Kwik Lift Mast, one of the Rambler Rig models, is equipped with four hydraulic rams, one mounted at each corner. The rams will lift the entire unit eight feet in a single stroke and provide a floor elevation of nine feet. Centralized control permits proper coordination of the four rams. Safety measures have been provided for proper lowering of the rig. The entire unit can be raised from ground level to full ram extension in eight to ten minutes.



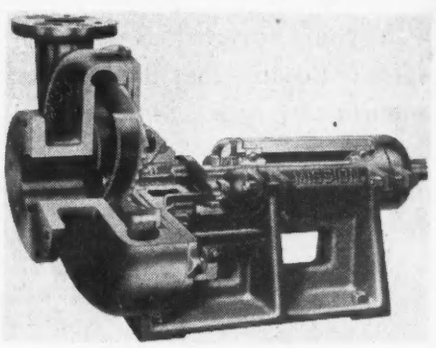
Special "A" frame substructure is provided to support the unit and is positioned when the rams are fully extended. The rig is then lowered to rest on the substructure. Mast is raised by hydraulic power to the upright position where it rests on a two section substructure that also supports the rotary and the setback mat.

Features of the Hy-Lift Ram system are the saving in time required for rigging up and the reduction in weight in substructure requirements. The Rambler Rig using the Hy-Lift Ram system can rig up in less than a day. Elimination of heavy ramps now in use in elevating portable rigs not only reduces by tons the weight of steel to be moved but also makes it possible to elevate the rig in locations where no room is available to maneuver the trailer up a long ramp.

For additional information write International Derrick & Equipment Company, 1315 Pacific Avenue, Dallas.

13—Centrifugal Pump

Departing from conventional design is a centrifugal pump with a concentric casing to reduce turbulence. Utilizing the Sherzer hydraulic principle, the pump's casing is said to eliminate much of the cavitation and turbulence found in volute-cased pumps. It is a single-stage, end suction type, with large nonclogging fluid passages permitting handling of slurries containing solids and materials in suspension.



Only four easily removable parts—casing, impeller, wear plate, and shaft—are in contact with the fluid pumped, and these are furnished in any workable alloy. This leads to wide application in corrosive services. Changes in capacity and head requirements within a wide range can be accomplished by the simple change of impeller diameter or of casing and impeller size.

Design is such that rapid repairs can be made. Flexibility of application is tied in with high interchangeability of parts.

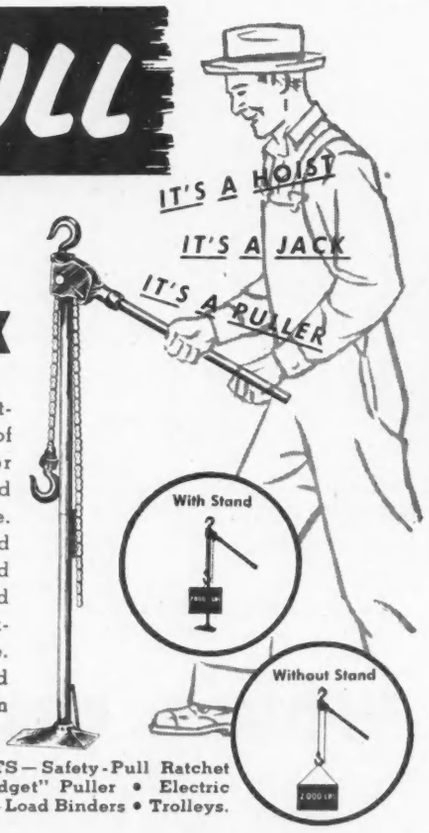
For additional information write the Mission Manufacturing Company, P. O. Box 1249, Houston 1.

LIFT or PULL

Easier and Faster—
with the Amazing New
COFFING HOIST-JACK

A versatile 3-in-1 tool, this new Coffing Hoist-Jack provides greater efficiency and ease of operation on scores of lifting, pulling or stretching jobs. Simplified ratchet design and sturdy construction assure safety and long life. Weighs only 23 pounds, yet lifts a 2000 pound load. Operates with stand as a jack, or without stand as a hoist or binder; quickly set up, easily portable. Tested to 100% over rated capacity. Write for Bulletin OHJ-1.

"SAFETY-PULL" HOISTS
Ratchet Lever type; Capacities from ¾ to 15 tons



OTHER COFFING PRODUCTS—Safety-Pull Ratchet Lever Hoists • "Mighty-Midget" Puller • Electric Hoists • Spur-Geared Hoists • Load Binders • Trolleys.

COFFING HOIST COMPANY
DANVILLE, ILLINOIS

Why Producers Prefer

JENSEN

Pumping Units

After all, producers are people, and like most people they prefer machinery that does its job dependably, without a lot of fuss and attention. Little wonder, then, that producers do prefer Jensens. For 28 years they have been built to meet rigid standards for service, performance, economy and dependability.

Once you find out about Jensens you'll prefer them, too. Check with any Jensen owner or your dealer. They have the answers for producers who demand even more reasons than people.

JENSEN BROTHERS MFG. CO.

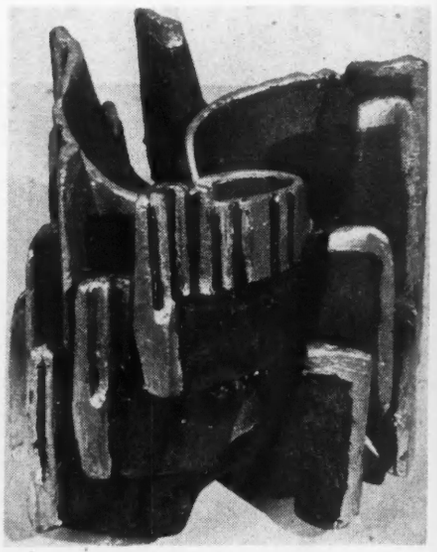
COFFEYVILLE, KANSAS

EXPORT OFFICE: 50 CHURCH STREET, NEW YORK CITY

14—Multi-Cutter Drilling Bit

A new type of drilling bit has been perfected which is designed to permit the attaching of any desired number of cutting edges. Although it ordinarily is supplied with from four to eight cutting edges, the bit may be equipped with as many as 20 to 30 if drilling conditions warrant. The cast steel, crescent-shaped cutting elements are hard-faced, and are so designed as to permit their being nested together or stacked on the end of the bit shank and welded in place to form a single unit. As the bottom, or lower, unit wears down, the welding which holds it to the cluster wears off to expose the next cutter, thus permitting drilling to proceed without coming out of the hole to put on a new bit. Extensive tests have been made on practically every type of formation encountered in oil well drilling.

Curvature of the cutting edges of each unit is such as to throw cuttings outward against the wall of the hole, then upward to the surface. This feature, together with the manner in which the mud stream is played against the faces of the cutters, is said to eliminate tend-

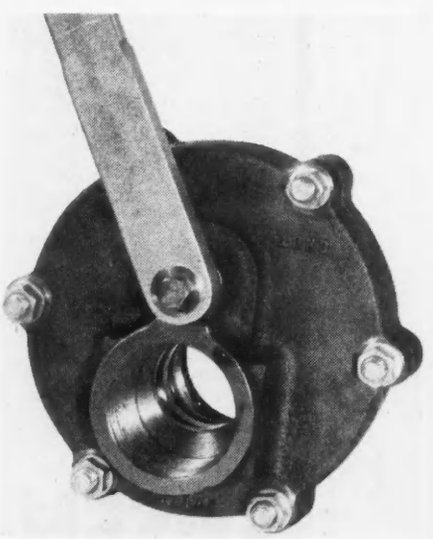


ency of the bit to ball up or become stuck in the hole. Faster table speeds and a lighter mud mix usually are desirable when using the bit. In addition, only ¼- to ¾-point of weight need be used. Available in sizes from six to 13¼ inches, the bits ordinarily are made up as eight-cutter units on a conventional threaded bit shank. In the illustration, white paint has been applied to those parts which are hard faced.

For additional information write Harvey D. Sandstone Company, P. O. Box 775, Los Angeles 28.

15—Quick-Opening Valve

Quick-opening operation, leak-proof characteristics and heavy-duty, all-steel construction are features of a new shutoff valve. Designed for butane and other similar service, the unit also is available



for water or corrosive service with a heavy cast bronze body.

The valve illustrated fits two-inch pipe size with a straight-through opening of 1-11/16-inch diameter. Only 18 pounds

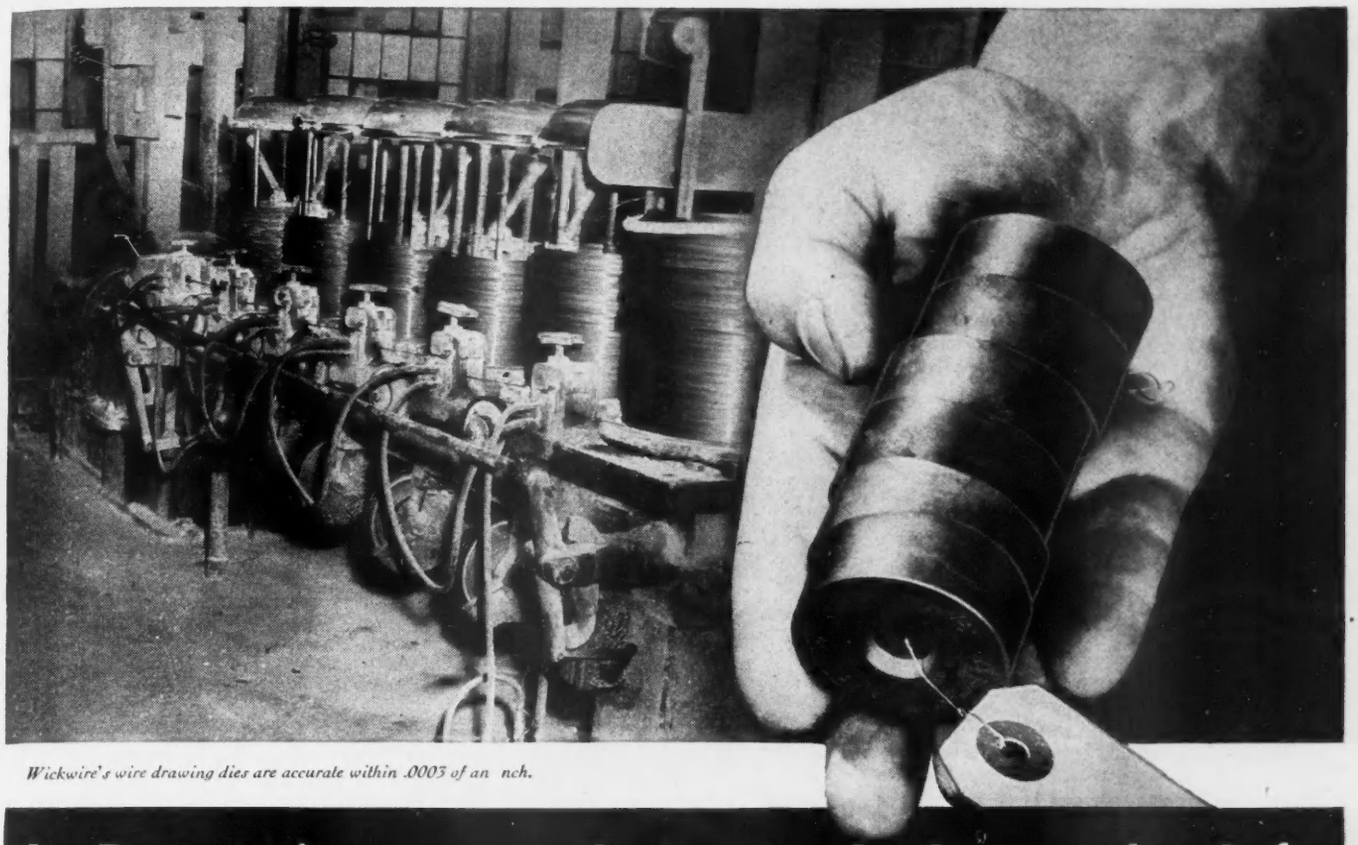
CMC PUMPS

UTILITY
DUAL PRIME
Model 37
3" Pump—7 H.P.

CMC Pumps are built for a wide range of services in the oil industry. Here, for example, is a Model 37 Pump mixing "mud" on a rotary drilling rig in Oklahoma. Our engineers will be glad to help you with your pumping problems.

CONSTRUCTION MACHINERY CO'S.
WATERLOO, IOWA
and
1903 Blodgett St., Houston, Texas
TELEPHONE HADLEY 3988

Specializing in High Pressure centrifugals, Dual Prime centrifugals and Diaphragm pumps for the oil fields.



Wickwire's wire drawing dies are accurate within .0003 of an inch.

In Rope Wire too—Reducing Methods Must be Safe

Making rope wire slim and strong is as scientific as any reducing method for humans—and a lot more certain of correct results. At the Wickwire plant, the size and sequence of wire drawing dies are carefully calibrated to provide for uniform reduction and to avoid the possibility of wire becoming brittle. Skipping of drafts, another cause of wire embrittlement, is eliminated by use of continuous wire drawing machines which will not function unless all dies are in their proper place.

Drawing, cleaning, heat treatment—every step necessary to reduce Wickwire Rope Wire to final size is closely supervised. The finished wire is accurate within a fraction of a thousandth of an inch. Production of strands and finished ropes is equally exacting.

All this adds up to Wickwire Rope being the logical choice of rope users who demand the utmost in performance, safety and long life. Wickwire Rope is available in all sizes and constructions, both regular lay and WISSCOLAY *Pre*formed. Wickwire Distributors and Rope Engineers are always ready to help solve your wire rope problems and supply the right rope for your needs.

HOW TO REDUCE ROPE COSTS AND PROLONG ROPE LIFE

Thousands of wire rope users have found that the information packed in the pages of "Know Your Ropes" has made their work easier. It's full of suggestions on proper selection, application and usage of wire rope. It's easy-to-read and profusely illustrated. For your free copy, write—Wire Rope Sales Office, Wickwire Spencer Steel, Palmer, Mass.

WICKWIRE ROPE

A PRODUCT OF THE WICKWIRE SPENCER STEEL DIVISION OF THE COLORADO FUEL AND IRON CORPORATION

CF&I & SUBSIDIARIES

WIRE ROPE SALES OFFICE AND PLANT—Palmer, Mass. **EXECUTIVE OFFICE**—500 Fifth Avenue, New York 18, N. Y.

SALES OFFICES—Abilene (Tex.) • Boston • Buffalo • Chattanooga • Chicago • Denver • Detroit • Emlenton (Pa.) • Fort Worth • Houston • New York • Philadelphia • Tulsa

PACIFIC COAST SUBSIDIARY—The California Wire Cloth Corporation, Oakland 6, California

force is required at the end of the handle to operate at 200 pounds per square inch.

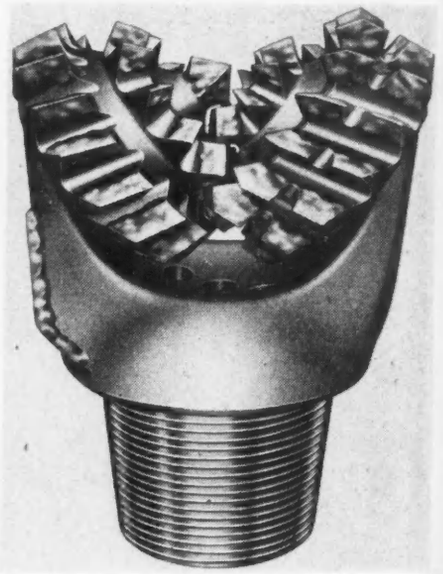
It employs a patented "Shear-Seal" principle which provides a metal-to-metal seal that is self-aligning and automatically compensates for wear. It is not critical to dirt because foreign materials are wiped away instead of lodging between the sealing surfaces.

The valve has only one basic moving part and requires no lubrication or packing adjustment throughout its life. Its design has evolved from extensive experience in building valves for liquid oxygen and other highly volatile fluids.

For additional information write Saval Company, 1915 East 51st Street, Los Angeles 11, Calif.

16—Two-Cutter Rock Bit

The Globe Two-Cutter rock bit incorporates a large bearing area together with larger ball and roller bearings, two features which, the manufacturers state, enable it to stay on bottom longer, and thus reduce round trips. Cutters are designed to dig fast, and their long, well-spaced teeeth are kept clean by the circulation, making these bits efficient in the stickiest formations. Another outstanding feature is its ability to dig a straight hole and straighten a crooked one. Geophysical crews may use the two-cutter rock bit in the small sizes (4½ and 4¾ inch) which are suited for top-to-bottom digging without changes.



It is manufactured in three different sizes: Type SS-2C for soft, sticky shales; Type S-2C for medium to hard shales; and Type M-2C for hard shales.

For additional information write Globe Oil Tools Company, Los Nietos, Cal.

17—Angle-Type Strainer

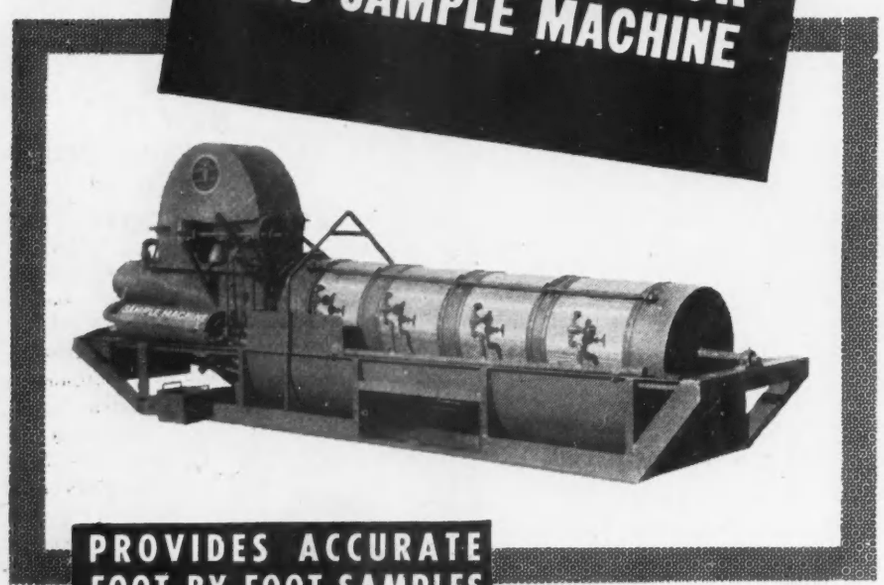
A strainer has been designed with an angle construction so that it may be installed directly upon the unit it is to protect. This is a particularly effective piping practice, as the strainer can be

installed when the equipment is first installed or even on the original equipment by the manufacturer, thereby saving time in handling and requiring fewer connections, fittings and piping space. These strainers are commonly used with pumping equipment and other close tolerance units.

Various types are made with the following pressure ratings: 125, 150, 250, and 300 pounds. The latter rating is particularly suitable for vapor, steam, gas or other high pressure service. To provide for corrosion resistance and special flow characteristics, strainer basket material and perforations usually are furnished to specifications as required for each installation. The body and cover assemblies are available in cast steel, semi-steel or bronze, depending upon the pressure requirement.

For additional information write J. A. Zurn Manufacturing Company, Everett & Pittsburgh Avenues, Erie, Penn.

THE Thompson SHALE SEPARATOR AND SAMPLE MACHINE



PROVIDES ACCURATE FOOT BY FOOT SAMPLES OF CUTTINGS TOO!

In addition to thoroughly reconditioning your drilling mud, the Thompson also provides accurate foot by foot samples of cuttings. The entire machine operates from flow of mud. IMPORTANT — Remember, Thompson pioneered the self-motivated Shale Separator. Its outstanding performance is due to years of development.

THOMPSON TOOL CO.
IOWA PARK, TEXAS

THE SHALE SEPARATOR THAT Really HANDLES THE LOAD

FIELD HOUSING is No Longer a PROBLEM

Field housing is no longer a problem for companies that specify STURDYBILT prefabricated, demountable buildings. We are prepared to save you time, worry and money by being responsible for your entire field housing problem from plans to erection on the site.

Specify STURDYBILT whether you need one small tool house or an oil field camp. The STURDYBILT 4' X 8' wall sections, precision built at the factory, can be adapted to suit nearly any floor plan, and they're easy to transport and erect. Write for Information.

MANUFACTURERS OF SPECIAL MILLWORK: DISTRIBUTORS OF JOHNS-MANVILLE INSULATION, ROOFING AND SIDING SHINGLES; CURTIS WOODWORK.

STURDYBILT

SOUTHERN MILL & MANUFACTURING CO.

• TULSA, OKLAHOMA •

Prefabricated, Demountable Houses

STURDYBILT HOUSES COMPLY WITH COMMERCIAL STANDARD CS125-45 OF THE NATIONAL BUREAU OF STANDARDS FOR PREFABRICATED HOMES

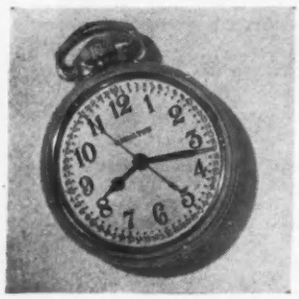
BE SURE TO CHECK

The Trading Post

PAGE 327

HAMILTON

22 Jewels



$39.50
(Tax Incl.)

Army Air Corps Surplus

Field engineers, chemical engineers, laboratory technicians, men who value their time, here is a remarkable value, U. S. Air Corps Hamilton Navigation Watch, converted to 12 hour dial with these outstanding features: 22 Jewels, sweep second hand, adjusted to six positions, stop watch feature. Easy to read dial. Guaranteed performance, sixty second indications. Fully reconditioned.

☆

15 JEWEL ELGIN

Made to U. S. Army Specifications

$21.95
Tax Included

Army Air Corps Surplus

Sturdy 15-Jewel ELGIN men's wrist watches. Water resistant. Sweep second hand, stainless steel back, unbreakable crystal. QUALITY! American made. Fully reconditioned. Made for the U. S. Army Air Corps. THEY HAD TO BE GOOD. Stainless steel band on watch. Guaranteed. *Ideal Christmas Gift.*

MAIL COUPON!

TURK'S JEWELRY
417 Main, Houston 2, Texas

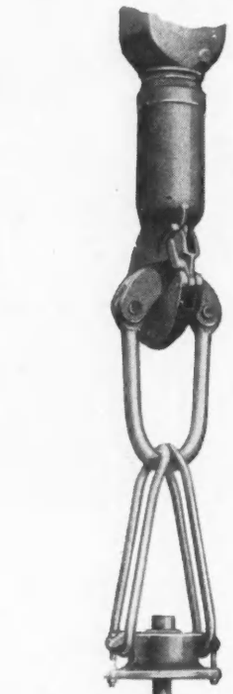
Please send C.O.D.
(Check watch desired)
☐ Hamilton—22 Jewel Pocket Watch @ $39.50
☐ Elgin—15 Jewel Wrist Watch @ $21.95

Name_____
Street_____
City_____
State_____

Shipped on open account to rated concerns
Established 1930

NEW EQUIPMENT
LITERATURE

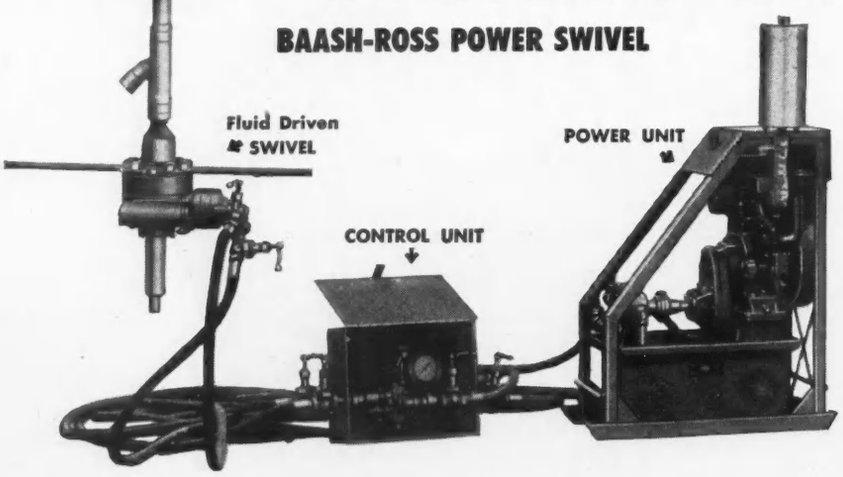
18—Fluid-Driven Power Swivel



The development of a fluid-driven power swivel permits light rotating jobs to be carried out on a rig without need for installing kelly, rotary table or other heavy equipment. Typical applications include internal cutting and fishing jobs, drilling out sand or cement bridges, scraping liners, drilling out cement in tubing, and many other similar operations where sensitive control is essential and only limited torque is required.

Basically, the power swivel consists of three units: the swivel itself, the control unit, and the power unit. The power unit consists of a compact gasoline engine which drives a fluid pump, thus generating hydraulic pressure which is circulated to the swivel by means of flexible hose connections. The control unit can be mounted where convenient and permits instant starting, stopping and reversing the direction of rotation of the swivel. A pressure gauge incorporated in the control unit gives accurate and direct indication of the amount of torque being developed in the rotating string so that complete control is maintained at all times.

The swivel unit can be suspended in the derrick with regular tubing elevators, and torque arms extend radially for anchoring the non-rotating portion of the swivel to the derrick legs so that torque can be developed without twisting the supporting lines. The swivel and fluid-drive unit are integrally combined into one compact housing and the lower end of the swivel connects directly to the run-in string. No kelly or rotary table is needed. The power swivel is designed to deliver maximum efficiency at a speed of approximately 17 revolutions per minute, the ideal



speed for operating fishing tools as well as other light rotating operations.

The swivel has a capacity of 80,000 pounds tensile loading and develops a torque of 12,675 inch-pounds. The 4-cycle gasoline engine develops approximately 9.2 horsepower at 2200 rpm and the magneto, sparkplugs and wiring are all spark-proof, while the exhaust is protected with a spark arrester for maximum safety where explosive conditions exist. The pump is equipped with a safety valve for 1000 psi maximum operating pressure.

The entire assembly—swivel, control unit, power plant and connecting equipment—is so compact that it can be readily transported in a small pickup truck. If desired, the power plant can be left right on the truck for quick jobs or can be set off at any convenient place on or near the rig.

Additional information may be obtained by writing the Baash-Ross Tool Works, 5512 South Boyle Avenue, Los Angeles 11.

19—Amplifier

The "Microsen Amplifier" is an instrument which measures and amplifies

THE LAYNE "TUBING SET" Packer

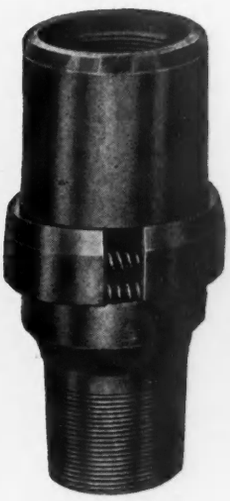
Packer

You can make one trip into the hole to do the job of two by using the Layne "Tubing Set" Packer.

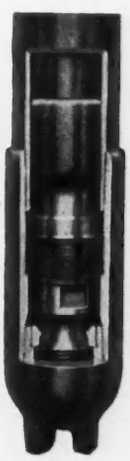
You can save time and expense of coming out with the Setting Tool and can be used with any type tubing head or christmas tree.

The signal closing set shoe, screen liner and packer are run in the casing with the tubing connected in the set shoe and not the packer.

This packer has 36 inches of canvas and it sets with the sleeve down. With the canvas "on top," the canvas fold begins on bottom when packer is set.


Collapsing Tool

Letting in Tool


Tubing Set Shoe

With the Signal Closing Set Shoe there is no guessing. You know when it is securely closed.

If the pump is run slowly while the valve is being closed, circulation will stop entirely when the valve is completely closed. When the letting in tool is released from the valve, circulation will start again.

Write for Complete Information

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30 Rockefeller Plaza
New York, N. Y.

General Office & Factory
8000 Market Street Houston, Texas

WEST COAST:
Layne & Bowler Corp.,
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minute power impulses as low as 0.2 micro volts.

A new principle in D.C. amplification is introduced which makes possible a combination of sensitivity and stability heretofore impossible in a rugged and compact laboratory instrument.

Power inputs from ironization, photo-electric cells, thermo-couples, or a Wheatstone Bridge are amplified by means of an electro-mechanical balance, giving an output signal directly proportional to the input signal. The amplifier has an isolated input circuit which is insulated from the output and ground. Input is measured and output stabilized through a feedback circuit. The instrument incorporates a mechanical zero adjustment with sufficient range to permit operation from various reference voltages, an adjustable gain, no lower frequency limit, and low input resistance.

This new principle permits a simplicity of design which can be manufactured at relatively low cost. No extended warmup period is required, standard tubes to commercial tolerances are used, and no tube matching is required.

For additional information write Manning, Maxwell & Moore, Inc., Bridgeport 2, Conn.

Merry Christmas

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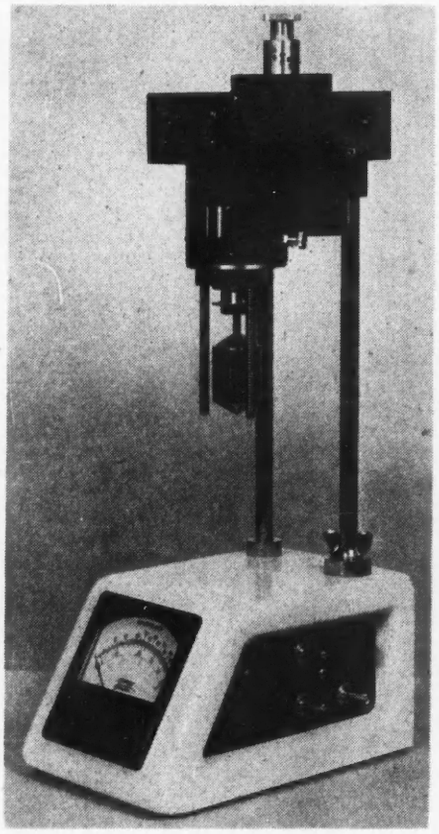
MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

20—Electric Viscosimeter

The Fann electric viscosimeter incorporates a new torque measuring principle to give rapid, reliable determinations of drilling mud viscosity and gel properties. Readings are taken directly from



the meter in the base of the instrument and no driving weights or calibration charts are required. An electric motor drives the rotor through a precision gear train at speeds of 600, 400, 200 and 100 revolutions per minute, giving a wide range in rate of shear. All parts of the instrument that come in contact with the fluid being tested are stainless steel and are designed for accessibility and easy cleaning. The bearings and other working parts are totally enclosed in dust-tight housings and are lubricated for life.

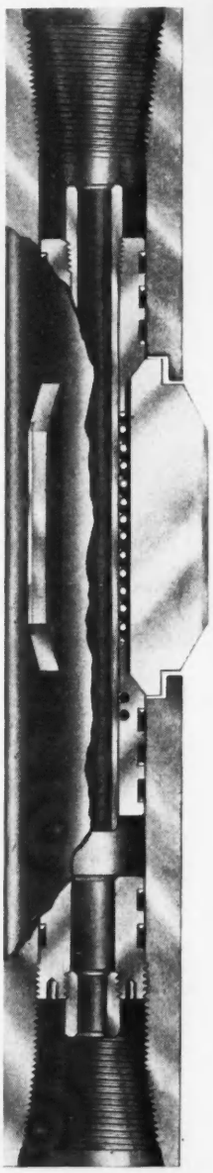
Two models are in production. The field instrument has a six-volt motor which plugs into an automobile storage battery. By means of an electric governor which is incorporated in the motor the speed variation is held within 2 percent. A 110-volt synchronous motor is used in the laboratory model.

For further information, write Geophysical Machine Works, P. O. Box 6101, Houston.

21—Tubing Tool Joints

Designed primarily for use in conjunction with standard production tubing where the same tubing is used for both workover and producing operations is a new tubing tool joint.

These joints are to be installed one to each stand of tubing, and by the use of a male connection on bottom, the joint is screwed directly into the tubing collar



One of the easiest and most effective ways you can safeguard well completion work is to run a Grant Casing Scraper above the bit when drilling out cement! This efficient tool — under full control of the operator at all times — completely removes cement, mud and other foreign material from the casing wall . . . smooths off burrs made by gun perforating . . . paves the way for free, unobstructed passage of pipe and tools . . . insures positive slip engagement of packers and other production equipment. *It's not only a valuable tool for new well completion, but also for use on work-over jobs during the producing life of the well!*

OPERATED BY PUMP PRESSURE

When running in the hole, the blades remain retracted and are expanded by simply applying mud pump pressure whenever scraping is to begin. Thus, the blades do not ride the casing going into the hole, eliminating blade wear and insuring full scraping efficiency. Blades retract easily on removal of pump pressure. Moreover, any degree of scraping pressure can be obtained by simply adjusting pump pressure, providing proper scraping action for any operation. Pump pressure adjustment is not critical, the tool operating properly over a wide pressure range. The Grant Casing Scraper can also be adapted to run safely on tubing.

Grant Casing Scraper bodies are machined from alloy steel, heat treated for strength and long wearing life. Scraping blades — securely locked in the body to prevent loss — are made of carbon steel, hard-faced for full cutting efficiency. *For safer, easier, more economical completion and workover jobs, get full details on the Grant Hydraulic Expansion Casing Scraper from the Grant representative in your territory. Send for Bulletin No. 17 giving body sizes, scraping ranges and complete descriptive information.*

Proven GRANT Tools
Used Where Performance Counts

Hydrostatic Bailers	Bulletin No. 11
Liner Pullers	Bulletin No. 14
Pressure Releases	Bulletin No. 15
Casing Scrapers	Bulletin No. 17
Wall Scrapers	Bulletin No. 20
Bottom Hole Scrapers	Bulletin No. 21
Underreamers (Rotary)	Bulletin No. 24
Underreamers (Cable Tool)	Bulletin No. 27
"Forjaloy" Hole Enlargers	Bulletin No. 38
Reamers	Bulletin No. 43
Hydrostatic Perforation Cleaners	Bulletin No. 50
Dump Bailers	Bulletin No. 51
Roller Cutter Shale Bits	Bulletin No. 54
Sand Pumps	Bulletin No. 55
Impression Block Tool	Bulletin No. 56
Well Cleanout Equipment	Bulletin No. 57

Write for Descriptive Bulletins on these GRANT Tools

GRANT OIL TOOL COMPANY

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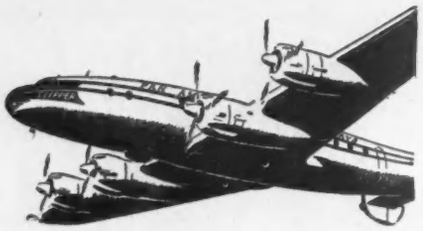

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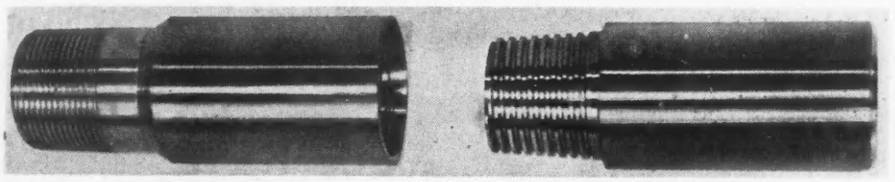
eliminating the necessity for pulling collars.

With the tool joint in place on each stand of tubing all make and break wear as well as tong wear is taken by the tool joint rather than by the tubing and the coupling. The fast-tapered, coarse-threaded, shouldered joint speeds up



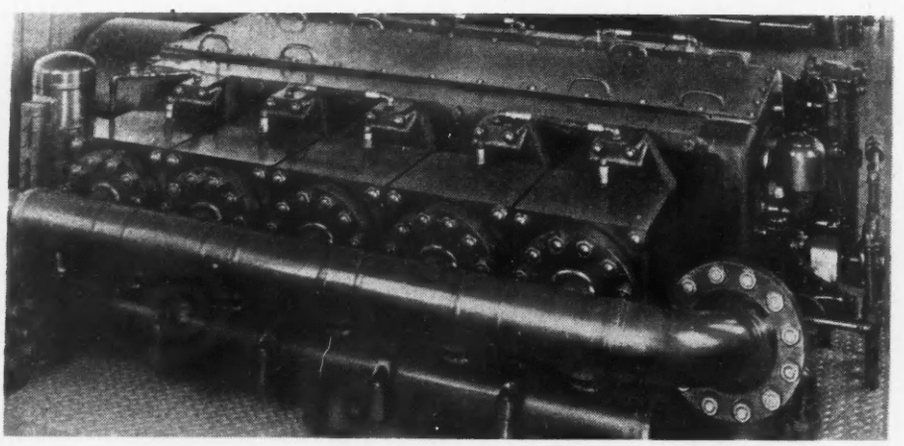
round trips by 20 to 40 percent. Thus, a saving in both rig time and material is afforded the operator.

The outside diameter of the tool joint is the same as that of the conventional tubing collar and the inside diameter is the same as the bore of standard tubing, thus allowing full clearance for all well practices.

By the use of heat-treated alloy steel, together with the most modern methods of manufacturing, the operator is assured of maximum efficiency and uniformity in this product.

In actual field tests this joint has met every known requirement such as speed in running, seal under high pressure, resistance to galling, ease in stabbing, as well as having ample safety factor in compression, tension and torque.

For additional information write Gulf Tool Company, P.O. Box 707, Houston 1.



22—Liquid Pump

The "Twin-Line" high-pressure liquid pump is said to offer great flexibility in handling a variety of liquids at volumes up to 64,000 barrels per day and pressures up to 2000 pounds per square inch. This new development, which is revolutionary in design and construction, has many applications, such as oil pipe lines, pressure maintenance by water injection in oil production, and for water flooding.

The "Twin-Line" design offers a comparatively large volume output and a great reduction in overall weight and space through the application of high rotative speeds to opposed, short-stroke displacement plungers. The pump's normal speed of 400 revolutions per minute permits the economical use of a direct-connected prime mover in many installations, eliminating gear or belt speed reduction.

These versatile pumps can handle a great variety of liquids and pressure conditions. Speeds can be varied over a wide range; plungers are available in sizes from three to six inches in diameter; and the pump is built with 4, 6, 8, 10 or 12 cylinders.

The "package-type" valve assembly, containing both suction and discharge valves, can be removed and replaced by a spare unit in 12 to 15 minutes. Valve material can be varied to meet corrosive conditions. In addition, any single complete pump cylinder can be removed and replaced without disturbing any of the other cylinders.

The pump base is a heavily ribbed box-type Meehanite Metal casting, providing utmost rigidity at comparatively low weight. Connecting rods are of forged steel, and all crankshaft main and crankpin bearings are of the removable, precision type. All power end parts of the pump are lubricated by a full-pressure, self-contained lubricating system which includes continuous oil filtering.

The pump is 7 feet, 9 inches wide, 3 feet high, and varies in length from 4 feet, 8 inches for the "Twin-Two," or four-cylinder unit, to 9 feet, 10 inches for the "Twin-Six." Weights range from 14,750 pounds for the "Twin-Two" to 27,750 pounds for the "Twin-Six." Tests with a heavy grade of fuel oil show a volumetric efficiency of 95 percent minimum at 400 revolutions per minute with 1500 pounds per square inch discharge pressure, and still higher efficiency at lower speeds and pressures. The mechanical efficiency is above 92 percent.

For additional information write The Cooper-Bessemer Corporation, Mount Vernon, Ohio.

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To 8,000-15,000 Feet

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CARDWELL MFG. CO., INC.

This Model O Draw Works depends upon rugged SKF Bearings in drilling to 8,000 feet with 4½-inch drill pipe and rotary servicing to 15,000 feet. These bearings are located on both drums, countershaft, transmission, engine drive and mud pump drive shafts. Needing only occasional lubrication, they have *stamina* for day-in and day-out performance . . . *inherent alignment* that eliminates bearing binding . . . *load distribution* that's equalized . . . *high load-carrying capacity* that's available for useful work at all times. When bearings are recommended for hard-working machines in the oil fields, the name most frequently mentioned is "SKF". 6363

SKF INDUSTRIES, INC.
Front St. & Erie Ave., Phila. 32, Pa.

23—Crown and Traveling Blocks

Bulletin CTB-47 gives data on crown and traveling blocks ranging from 65- to 500-ton capacities. Of particular note is information on the new "Shorty Blocks" for operation in masts.

Published by International Derrick & Equipment Company, 875 Michigan Avenue, Columbus, Ohio.

24—Blocks

Catalog No. 48 contains the latest information on blocks designed primarily to meet the needs of the petroleum and allied industries. Every type block has been illustrated and detailed information regarding its uses and construction is given.

Several new type blocks are shown in the catalog. Among the blocks featured is the new cargo hoister. It is a high speed Timken Bearing block built to stand up under extra severe duty. Another new product is the Rotary Hose Guide Puller.

Published by McKissick Products Corporation, P. O. Box 2496, Tulsa 1.

25—V-Belt Drives

A 144-page, indexed catalog entitled, "Pre-Engineered Texrope Drives," greatly simplifies the problem of selecting V-belt drives. Nearly two-thirds of the new book is devoted exclusively to pre-engineered stock Texrope drives for all applications from one to 150 horsepower. More than 22,000 stock drives are listed in this section. Drives for all horsepowers, motor speeds, ratios and driven speeds have been accurately pre-engineered and are systematically listed according to horsepowers.

Published by Allis-Chalmers Manufacturing Company, P. O. Box 512, Milwaukee 1.

26—Packers, Pumps

The complete line of oil and gas well packers, sand pumps, drilling tools and water well supplies manufactured by Larkin & Company, is presented in a new catalog, No. 50. The 88-page book gives technical descriptions, pictures and prices of all equipment. Discount sheets of complete new pages will be issued periodically to keep the prices in the catalog up to date. Pages covering new equipment will also be issued for catalog insertion.

Published by Larkin & Company, Butler, Penn.

27—Oil Field Catalog

A catalog of oil field equipment contins accurate and colorful drawings of each Guiberson product, and offers a complete presentation of the extensive list of tools and parts, including specifications and prices.

Production equipment is first shown, followed by a section devoted to drilling tools and supplies. The last portion of the booklet lists miscellaneous products such as unions, adapters, etc.

Published by The Guiberson Corporation, P. O. Box 1106, Dallas 1.

28—Wrought Iron Data

A 20-page illustrated booklet that describes wrought iron is "The ABC's of Wrought Iron."

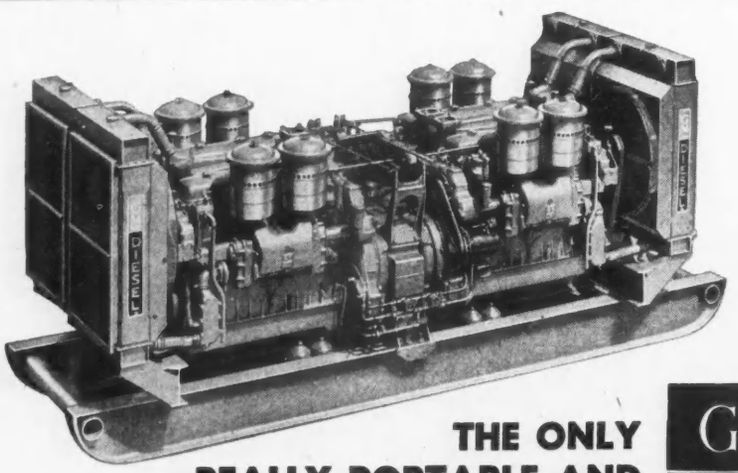
The booklet tells in non-technical terms what wrought iron is, why it resists corrosion and withstands shock and vibration, how it is made, and how it is bent, welded and threaded. The various services for which wrought iron pipe and plates are used are depicted.

Published by A. M. Byers Company, Pittsburgh.

29—Plastic-Coated Pipe

Development of plastic-coated drill pipe for drilling oil wells in highly corrosive fields is told in a 22-page booklet describing the problem of corrosion fatigue, its economic considerations, history of the development of the new pipe, reasons for the selection of the thermo-setting plastic, results of the field and the laboratory test program, and the story of its manufacture. Twelve photographs illustrate the descriptive material.

Published by Spang-Chalfant Division, The National Supply Company, Toledo, 1.



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GM "QUAD"

Any number, or all, of the four engines of a GM "Quad" can be operated, depending upon the power requirements. It is even possible to remove one engine from a "Quad" unit, and take it into a shop for repair while the other three could still be operating. Each engine of a "Quad" is controlled by an individual clutch and throttle.

This series of engines is built from a two-cylinder to a twenty-four cylinder unit, with all of the wearing parts, such as pistons, valves, and bearings interchangeable, thus simplifying the maintenance problem of drilling engines. Quads can easily be coupled-up to the conventional compound mechanism of a drawworks.

The Portability of a GM "Quad" makes it highly adaptable to all types of marine drilling operations.

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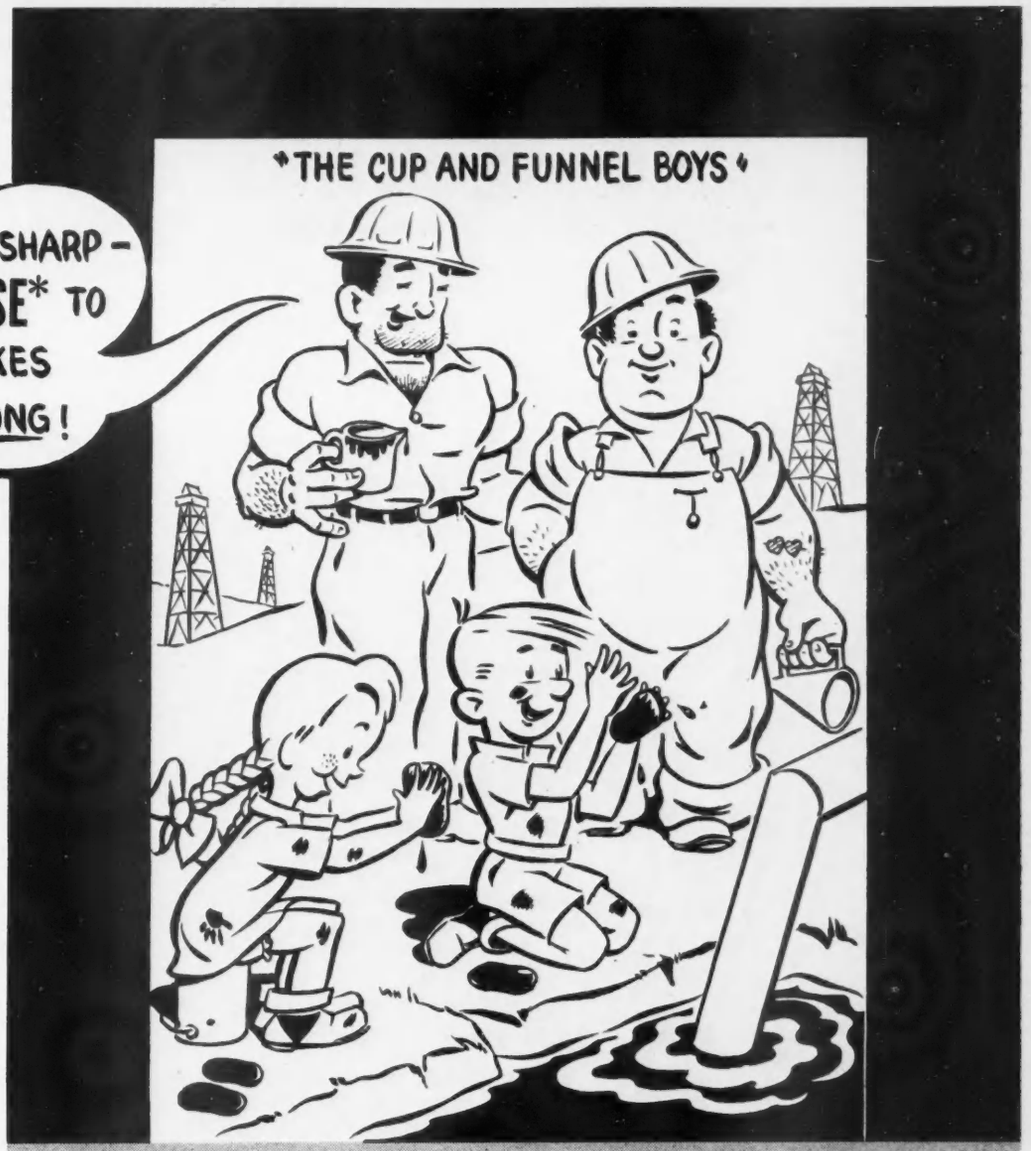

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Associations

Gas Association Officers Reelected

Four officers of the Independent Natural Gas Association of America who were reelected at the annual meeting in Oklahoma City. Left to right are Paul Kayser, president of El Paso Natural Gas Company, Houston, first vice president; Joseph Bowes, president of Oklahoma Natural Gas Company, Tulsa, president; John A. Ferguson, Washington, D. C., executive director; and F. W. Peters, treasurer of Oklahoma Natural Gas Company, Tulsa, treasurer. Also reelected was J. H. Dunn, president of Shamrock Oil and Gas Company, Amarillo, second vice president.

Important Papers Given at API Session Abstracted

Abstracts of some important papers given at the annual meeting of the API last month at Chicago are as follows:

Results of Water Injection in Woodbine Reservoir of the East Texas Field

By W. S. MORRIS,
East Texas Salt Water Disposal Company, Kilgore, Texas.

The East Texas field, discovered in 1930, is a monoclinal type structure producing by water-drive. Covering an area of more than 200 square miles, the field had a recoverable oil reserve estimated as high as 5 billion barrels, of which about 2,350,000,000 have been produced.

Since 1938, when the first injection well demonstrated the feasibility of water disposal into the Woodbine, more than 644 million barrels of salt water have been returned to the formation. Seventy-five injection wells now are in use. Contamination and pollution of watersheds have been practically eliminated. Bottom-hole pressure in the field showed an increase of 14.91 pounds per square inch during 1945 and 0.05 psi in 1946. Since the East Texas Salt Water Disposal Company commenced operations in 1942, the reservoir pressure declined only 7.86 psi to July 1, during which time more than 606 million barrels of oil were produced. This rate is more than 77 million barrels of oil per pound pressure loss.

The salt water flows by gravity from the various leases through asbestos-cement pipe to the open-treating plants. Here the water is aerated and subjected to a treatment of chlorine, lime and alum, then permitted to settle for 24 hours before injected to the Woodbine. It is more economical to stabilize the water than to clean the injecting wells that have become clogged.

The salt-water disposal program is an outstanding conservation measure, worked out by the oil operators and the Railroad Commission of Texas. It is estimated that the recoverable reserves have been increased by more than 600 million barrels of oil as a direct result of the project.

The Formation and Operation of Cooperative Projects in Secondary Recovery

By D. V. CARTER,
Magnolia Petroleum Company, Dallas.

Cooperative projects in secondary recovery have played and will play a very important role toward increasing the ultimate recovery of oil and gas as well as the attendant operators' profits. The past 20 years have seen the largest general acceptance to such agreements among secondary-recovery operators. These projects came into being because they are the simplest mechanism by which a unified effort can be achieved. Such agreements are different from pooling and unitization in that they allow each operator to retain title and operation of his lease.

Four essential types of cooperative secondary-recovery agreements now in general use are (1) multiple committee; (2) single committee; (3) letter of agreement; and (4) verbal agreement.

Joint or cooperative operation has many advantages over ordinary operation, one of the most important being the opportunity for combining a variety of experiences for mutual benefit, a situation which also tends to dispel

misunderstandings and suspicion. This type of project may be considered an evolutionary improvement toward a unit operation. Cooperative agreements also have a number of disadvantages, most of which are eliminated in unit operation. The main disadvantage when compared with unit operation is that of inflexibility. Usefulness of the cooperative agreements certainly has not passed. In many cases, its efficiency, under certain favorable conditions, approaches or equals that of complete unitization. The technical advancements and improvements in human relations between operators and royalty owners serve to keep the cooperative agreement alive for the purpose of reducing costs and increasing ultimate recovery.

The Economics of Secondary Oil Recovery

By W. B. BERWALD,
Study Group Leader, The Ohio Oil Company, Findlay, Ohio.

The economics of secondary recovery are similar to those of primary production. When the cost of finding and developing new reserves is high and the price of oil is high, secondary-recovery programs in old fields are more feasible.

Principal factors governing the economics of individual secondary-recovery projects are the volume of oil that can be recovered, the depth to the producing formation, and the price and demand for the oil. Other factors include the cost of the prospect, condition of primary-production equipment, availability and cost of gas for repressuring or water for water flooding, fuel and power cost, transportation facilities, location, size and shape of the property, availability and cost of labor and field services, and the type of secondary-recovery method used.

Total costs for oil recovered by secondary-recovery methods are high. The most important is the capital cost of acquiring and developing the property. Evaluation and engineering studies are included in the capital costs and are a part of the development costs. Operating costs, although often higher on a per-barrel-of-oil-recovered basis than development costs, usually are less important.

Secondary-recovery operations have proven feasible in many areas for years. The economic risks involved are less than those in primary-recovery operations. Current trends in the economics of primary-recovery operations indicate that secondary-recovery operations in many areas offer a means of increasing recoverable oil reserves, to a limited extent, that is more satisfactory economically than primary-recovery methods.

Plans and Purposes of the Interstate Oil Compact Commission Dealing with Secondary-Recovery Operations

By EARL FOSTER,
Executive Secretary, Interstate Oil Compact Commission, Oklahoma City.

Secondary recovery has held the active interest of the Interstate Oil Compact Commission since its organization in 1935. Its sole purpose is the prevention of physical waste, retention in the states of the rights and authority to control their own resources, and to recommend measures for the greatest ultimate recovery of oil and gas. A secondary-recovery division of the Commission has been established to carry out a five-point

***It Is Enabling 3 Million Fewer Farmers To Harvest Food From 20 Million More Acres**

War service and war work thinned the ranks of American farmers by 5 million. There still are 3 million fewer farmers than in 1940. Yet, since 1940, farm production has increased one-third.

Hard work and good weather helped. But, this Bunyanesque feat of production could not have been accomplished had it not been for the mechanization of farms.

Without steel, cheap steel, mechanization could not have been brought to the farms and the world would be more than hungry—it would be starved.

Vastly increased farm mechanization has taken place in the last ten years. In that time the composite price of finished steel, as published by Iron Age, has increased only about ½¢ per pound. This modest increase in the base price of steel as obtained by the mill has little effect on the ultimate cost to the consumer of steel products.

Steel is the most essential and the cheapest of all metals.

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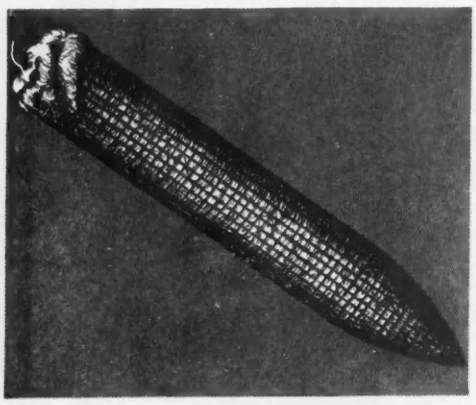
SHEFFIELD STEEL

SALES OFFICES: Chicago, Ill.; St. Louis, Mo.; Des Moines, Ia.; Wichita, Kans.; Denver, Colo.; Oklahoma City, Okla.; Dallas, Tex.; San Antonio, Tex.; New Orleans, La.

program. Many of those serving in this division are members of the API standing Subcommittee on Secondary-Recovery Methods, and unusual opportunities for coordination of activity exist.

Because of the very nature of the Compact Commission, it can promote proper legislation permitting secondary-recovery operations and unitization of oil fields in states not now possessing adequate laws. It will collect data from other sources on the subject and publish statistics and information on secondary recovery. Reserves of the nation will be studied under the cooperation of the Joint Stripper-Well Committee. This information will be made available to the state legislative bodies and to the oil industry.

The Compact also will encourage larger secondary-recovery research programs not only in the industry, but by the states themselves. It intends to maintain close contact with federal agencies interested in oil production and the country's reserves in the hope that its program will help demonstrate that the states are keenly mindful of their obligation to produce oil efficiently and in the best interests of the nation. The Compact's work is not intended to supersede or duplicate the work of other agencies, but is planned to perform a function not now being performed.



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A Survey of Dual Completions

By E. B. MILLER, JR.,
Tide Water Associated Oil Co., Houston.

Urgent conservation of steel during the war plus government restrictions on the number of wells permitted on given surface areas brought encouragement to the practice of dually completing oil wells. Although the critical shortage in tubular goods still exists, there has been a decline since 1945 in the number of wells completed dually. A survey of the API Southwestern District of the Division of Production showed that during 1940-1947, 1319 wells were dually completed, the greatest number for any one year being 360 reported in 1945.

Problems of corrosion and cessation of natural flow from one or both producing zones were reasons for reducing the number of wells to be completed as dual producers. Limitations such as providing artificial lift facilities when one or both producing zones cease to flow naturally, and paraffin accumulation have been other barriers in dual completions. Experience gained during the past seven years has no doubt caused the operator to give serious study to the reservoir characteristics before entering upon any large-scale program of dual completions.

The almost unanimous opinion of the operators, according to the study, was that dually producing wells have no advantage from an operating viewpoint over the single completion. The only advantage of the dual completion lies in the saving of material in the initial development.

MER—A History

By EDGAR KRAUS,
The Atlantic Refining Company, Dallas.

Overproduction in many fields from 1927 to 1931, including the East Texas, resulted in restrictions and finally state-regulated proration. The reservoir engineer began his work in 1933 on determinations of the effect of restricted production on the reservoir. Out of this study came discussions of factors which would insure "maximum economic revorey." Rates of production were suggested that would result in a minimum gas-oil ratio. Reserves also were suggested as a factor in allocation. Both legal and technical committees recommended rates of production that would minimize physical waste. The earliest mention of MER is contained in an API report in 1938, "Engineering and Economic Phases of Well Spacing." It stated, "It is generally agreed that the maximum rate at which a pool can be produced efficiently and economically can be determined."

In 1941, further reports in the factor "range of rates." A year later it was argued as being doubtful that an optimum rate of production could be determined accurately. From these investigations crystalized the concept of the maximum in the range of efficient production rates, hence, maximum efficient rate, or "MER."

Maximum efficient rate was used for inter-pool allocation in California in 1942, and was defined as follows: "The maximum efficient rate for an oil pool is defined as the highest daily rate of production that can be sustained by a field or pool for a period of six months without jeopardizing maximum practicable

utimate recovery from the reservoir." There is no commonly accepted definition at the present. There is disagreement concerning the proper use of MER and only two states have given recognition to it.

Application of the Shaped-Charge Process to Petroleum Production

By ROBERT H. McLEMORE,
Well Explosives, Inc., Fort Worth.

The cavity effect of explosives or the "Munroe effect" has been known since the 1880's; however, no practical application was made until the war years. Numerous tests showed that, if the cavity in the head of the explosive was lined with certain materials, and the cavity directed at the object to be penetrated, unusual results were obtained.

Extensive research has shown that upon detonation, a jet is generated which penetrates the taget, to be followed by the collapsed liner, called the "carrot." The distance from the base of the liner to the first obstruction is called the "standoff distance" and is very important in obtaining an efficient jet. Many problems surrounding the application of the process to petroleum production have been overcome, and its use in casing perforating and open-hole blasting has received much attention.

Two charges are used for casing perforation. The 28-g charge is designed for 6⅝-inch outside diameter and larger casing, while the 21-g charge is used primarily for 5½-inch casing. Both sizes are capable of opening the casing and penetrating the cement for a distance of six to nine inches, depending on the strength of the latter. The casing burrs somewhat, but the cement does not crack or fissure. A pocket is formed in the cement when the jet emerges from the casing. No splitting has been encountered in the casing when as many as 12 shots per foot were fired. Explosives used are relatively insensitive to shock, have a high rate of detonation, a high energy content, will burn without detonating, and are sensitive to primacord detonation.

Applications in open-hole blasting still are in the experimental stage, but the shaped charges used are of the same basic design and larger. The final development of this process will be a valuable asset in the economical production of oil and as a means of securing greater ultimate recovery.

The National Transportation Survey

By JOHN H. FREDERICK,
Professor of Transportation, University of Maryland, College Park, Md.

This paper reviews the material gathered by replies to a list of topics sent out by the Lea Committee of the House of Representatives to invite helpful suggestions on matters concerning transportation. The speaker was retained as consultant on the project, and the work of analyzing and compiling the replies was completed by the filing of a report in December, 1946.

Among the findings was that the consensus of opinion of carriers and other respondents was largely in favor of a single regulatory agency. A general opinion prevailed that the Interstate Commerce Commission would require reorganization were this body given regulatory control over air transportation.

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Sentiment, particularly as expressed by users of transportation, was overwhelmingly in favor of exemption of common carriers from application of anti-trust statutes when activities were under supervision of the regulatory agency. General opinion was likewise overwhelmingly against federal agencies engaging in the promotion of common-carrier activities.

It was felt that the law should not force coordinated services, but that carriers be permitted and encouraged to coordinate.

Opinion was largely against federal aid to transportation agencies. There was unanimity of opinion that the federal government possesses the legal authority and public duty to remove state barriers to the free flow of commerce.

Tanker Transportation and Remarks on Inland-Waterway Operations

By M. G. GAMBLE,
Standard Oil Company of New Jersey, New York City.

The foremost question within the industry today on the subject is "Are there enough tankers?" As of October 1, the speaker reported that there were approximately 96 government owned T-2 type vessels in tie-up. These, funneled to the industry through the time-consuming transfer from the U. S. Maritime Commission, would provide adequate capacity, the last probably not being available until several months after actual purchase, due to extensive shipyard overhaul.

The T-2 and other relatively high-speed tankers are justified on the basis of reduced transit and turn-around time, as the greater fuel requirements for the 14½ knot speed over the prewar ten-knot average does not amount to as much as the daily operating savings—including payroll—of the faster ships.

The inland-waterway transportation of petroleum products is shown to be principally in non-propelled equipment, due to the loss of investment time while self-propelled units are being loaded and discharged. In instances cited by the speaker, a single power unit could drive a fleet of 12 barges, providing for graduated discharge at as many different ports if necessary, and leaving the towboat free to continue the distribution and consequent collection of the container units.

A principal advantage of water transport of petroleum is in its flexibility wherever conditions are otherwise favorable to its use. Both ocean-going tankers and inland-waterway equipment can readily be moved from one area to another to suit changed conditions. As petroleum becomes more extensively used throughout the world, the need for its transportation by water gains increasing importance. Best estimates of post-war shipping indicate that tankers will comprise almost half of the total U. S. merchant fleet.

Future Problems of Transportation of Petroleum by Highway

By J. W. SINCLAIR,
Union Oil of California, Los Angeles.

The future problems of transportation are in a preponderant degree dependent upon the ability of those within and without the industry to:

1. Continue to progress in the design and construction not only of the vehicle proper, but also the tank and delivery appliances placed thereon.
2. Keep free from strangulatory legislative impediments and extremes in regulatory control.
3. Effect full and provident use of the vehicle.
4. Retain and further enhance good public relations with other users of the highway.

The speaker pointed out that millions of Americans make their only contact with the oil industry on the highways—through the media of the filling station and the tank trucks which provide those stations with their basic commodities.

Inherent antipathy of the highway user to trucks of all kinds can be overcome by the industry in selecting and training driver personnel with the same exacting care exercised in selecting stillmen, drillers or pump-station engineers. To the extent that driver personnel is upgraded, to that extent may better public relations on the highway be expected. And good public relations on the highway are an indispensable requisite when confronted with adverse legislation which offers serious impediment to the legitimate transportation of petroleum products by highway.

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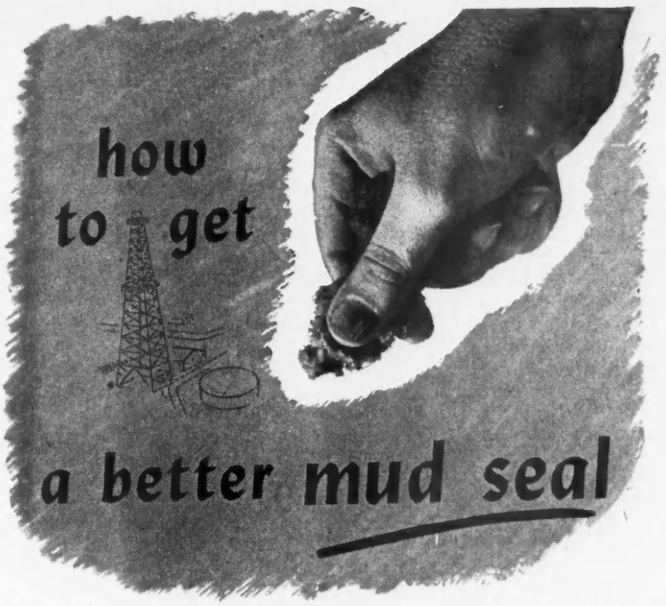

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Papers Given at AIME Fall Meetings Are Abstracted

Abstracts of papers given at the AIME fall meetings are as follows:

Mechanics of Wave Action on Structures

By WALTER H. MUNK, Scripps Institute of Oceanography, La Jolla, Calif.

Wave action encountered during offshore drilling is an increasingly important problem, particularly on the Gulf Coast where hurricane waves often reach 30 feet in height. It has been found that H-beam piers suffer six times the force of waves that cylindrical columns do, proving that the latter type is best suited for offshore drilling structures. Slides were used to illustrate the three principal types of waves—seas, swells and surf.

High seas generally are caused by nearby storms and swells by distant storms. By studying wave action, including the height and type of waves, together with distance of the storm and subsea topography, it is possible to forecast the type of wave action that can be expected at or near the shoreline. By reviewing past weather conditions for that area, it is possible to set up the maximum and minimum conditions which may be expected during a particular storm period. Calculations were given showing the period, depths and height of waves and how they affect structures. It was shown, for example, that the average wave has half of its height above and half below the mean ocean level. Because there are too many variables in forecasting and measuring wave action, it is best to use and apply both actual and theoretical knowledge.

Planning a Multiple Well Directional Drilling Program for Offshore Locations

By GORDON JACKSON, Vice President and General Manager, and J. B. MURDOCH, JR., Chief Survey Engineer, Eastman Oil Well Survey Company, Denver.

Photographs, drawings and charts are used to illustrate the mechanics in planning a complete directional program on an oil structure where the productive limits are known. Directional wells must be planned to take advantage of multiple zone completions, possible further deepening to lower zones, or the further perforating of a higher oil horizon. Under the last three conditions spacing is one of the most important factors and the proposal should be drawn so that each well can be used to the maximum benefit.

Ordinarily, the directional wells in a program are not all drilled at the same angle, so that unless the proper type of well proposal is chosen, the spacing is correct for only one zone. This factor frequently is overlooked and has resulted in the drilling of extra wells which careful planning would have made unnecessary. The location of the artificial island so that wells may be most advantageously drilled is influenced by the type and depth of the oil structure. The starting points of the wells should be located so that when they reach the productive zone the drift angle will be the proper one at which to penetrate the oil sands. Dip of the formation and type of oil structure also have a definite relationship to the proper drift angle or direction of the well. For example, it generally is more advantageous to penetrate the sand in a down-dip direction to give greater sand penetration. Drilling of lower-angled holes is recommended at the start, so that experience gained can be applied to subsequent higher angle wells.

Discussion of Some Electrical Log Interpretation Problems

By R. D. FORD, Schlumberger Well Surveying Corporation, Long Beach, Calif., and M. E. LOY, Schlumberger Well Surveying Corporation, Bakersfield, Calif.

More searching and careful analysis of electrical logs will eliminate many errors which lead to the misinterpretation of possible productive zones. Slides showing portions of a few California sand logs are presented and analyzed to show how correlations between wells may eliminate such errors. The resistivity as shown by an electrical log is an apparent resistivity which, in most cases, is not equivalent to the true resistivity owing to the factors including hole effect, bed thickness and electrode spacing. A true resistivity is essential for a reliable quantitative analysis. Therefore, if more than a rough interpretation is desired, corrections must be made for the above factors.

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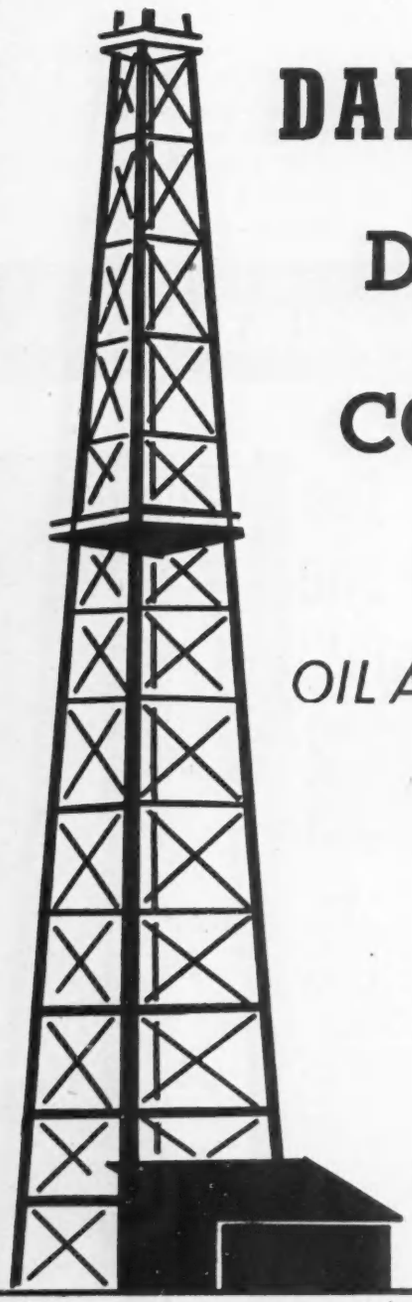

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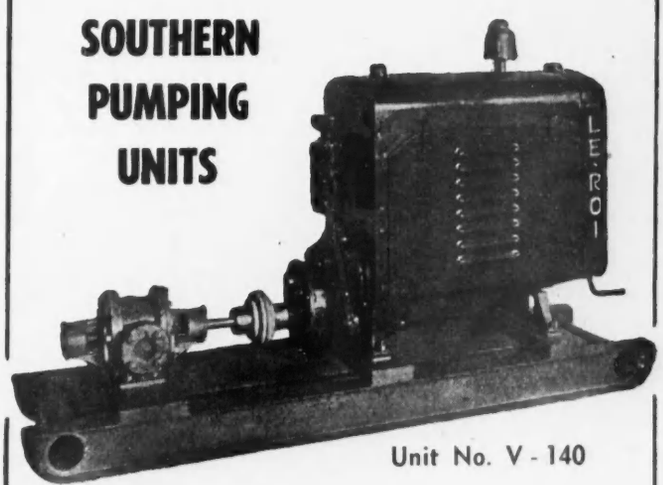

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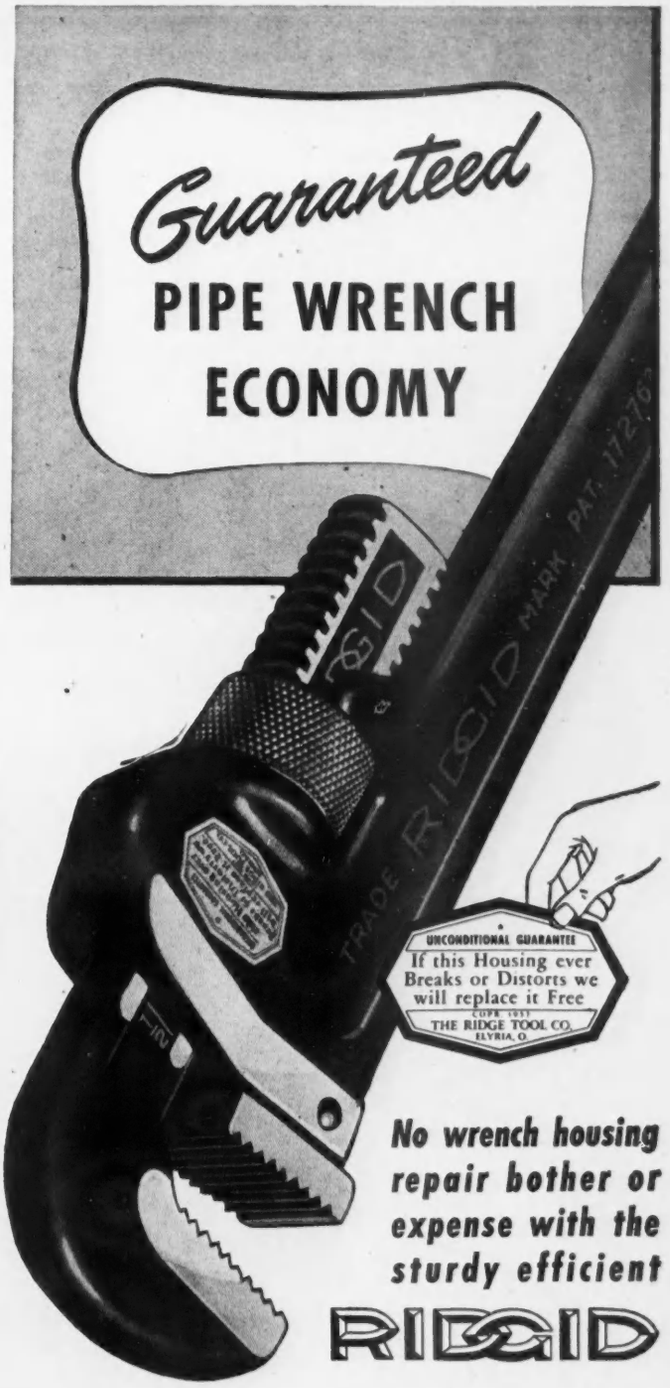
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interpretation of the electrical log to select zones of possibly less than 100 percent water saturation. Apparent resistivity may be used for this rough interpretation if its probable relationship to true resistivity is considered. Apparent resistivity is lower than the true resistivity when affected by bed thickness and electrode spacing except when the resistivities of the zones immediately above and below are higher. The hole effect on resistivity measurements is a complex phenomenon which may be evaluated practically by means of published resistivity departure curves. The hole effect upon the longer spacing measurements is generally of minor importance, but where the true resistivity of the formation and/or mud resistivity approaches extreme values it may assume importance and either a positive or negative correction must be applied to the apparent resistivity.

A Critical Review of Methods Used in The Estimation of Natural Gas Reserves

By HENRY J. GRUY and JACK A. CRICHTON, DeGolyer and MacNaughton, Dallas.

Estimators of gas reserves currently use the same general methods described by early authors, with the addition of certain refinements made possible by the greater amount of data presently available on gas reservoirs and the increased knowledge of reservoir mechanics.

The terms currently used by the American Gas Association to describe the various types of gas in accordance with the nature of its existence in the reservoir are (1) non-associated gas (free gas not in contact with crude oil in the reservoir); (2) associated gas (free gas in contact with crude oil in the reservoir); and (3) dissolved gas (gas in solution in crude oil in the reservoir). Estimation of reserves in the first type may be made using the volumetric method, wherein total area and volume of pore space are employed in calculating actual volume of gas present; and by the decline curve method which involves plotting reservoir pressures against cumulative production. Extrapolation of the curve gives ultimate recovery directly, but ignores the effect of deviations from Boyle's Law.

In the second type additional problems are encountered in estimating reserves. The volume of gas available from the gas cap may exceed the original volume because of migration of solution gas upstructure and the volume occupied by the gas cap may increase as oil is withdrawn or it may decrease due to movement of oil upstructures. Also, the volume of gas may not be known accurately because some oil wells near the gas-oil contact may produce associated gas as well as dissolved gas. Decline curves generally are inaccurate on this type of gas accumulation. In the third, or dissolved, gas type of reservoir, the principal method of estimation of gas reserves is a volumetric method. The recovery factor to be applied depends on the mechanics under which the reservoir will be produced. These factors are (1) water drive and (2) constant volume type reservoir. The latter involves the calculation of gas originally in place and subtracting from it the gas that is calculated to be unrecoverable at the expected abandonment pressure of the reservoir.

The Limits of Uncertainty of Average Permeability and Unit Volume Estimate of Oil in Place

By JAN LAW, Consultant, Los Angeles.

The author undertakes to establish an estimate of the limits of error or uncertainty associated with a mean derived from a sampling procedure. The problem of "least count" in porosity, permeability and interstitial water measurement is disregarded. The average permeability and the estimate of original oil in place per unit volume occupy a dominant position among those factors critical to production performance. The problems undertaken are attacked by the large sample method and in so doing, departure from elementary texts on mathematical statistics are made only in the use of the logarithm at a variable rather than the variable expressed in the units of measurement.

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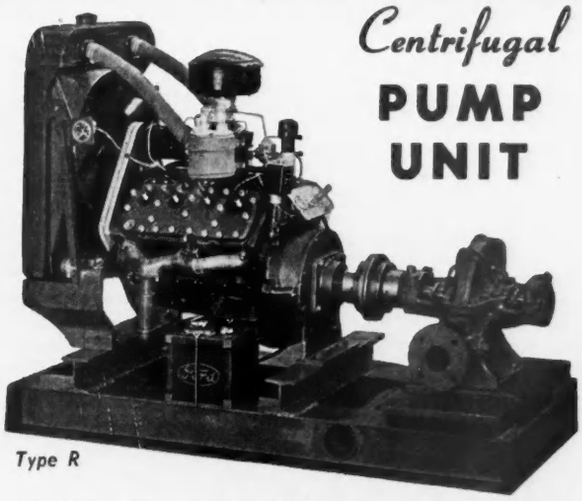

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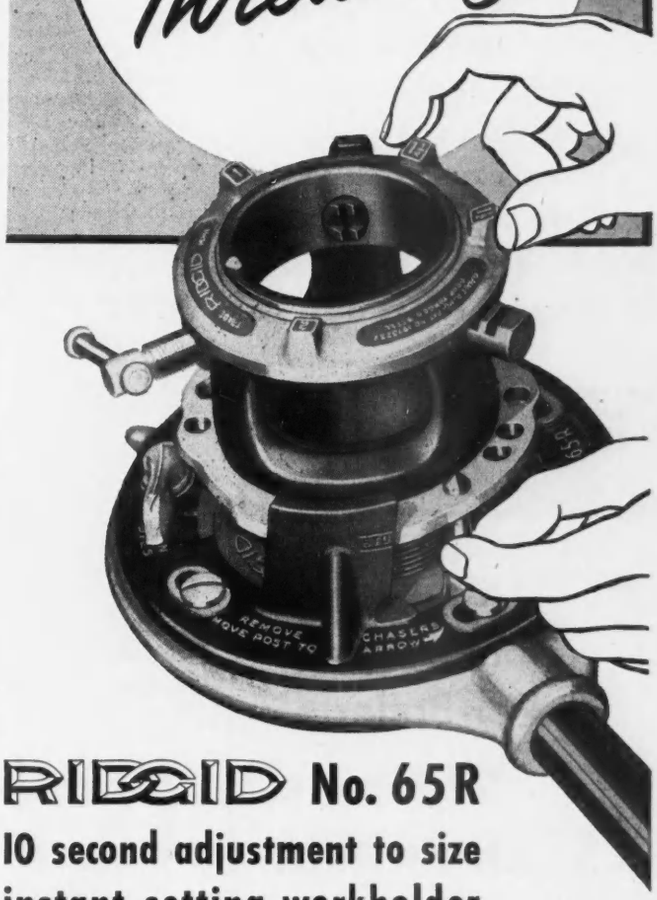

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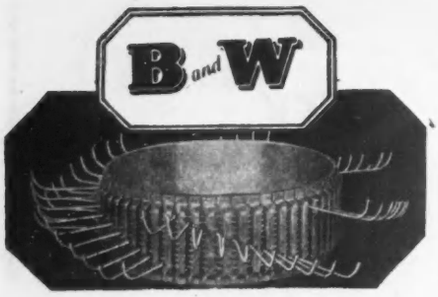

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ployed, was produced under sedimentary processes of a constancy of variation. Following extensive mathematical derivations, it is concluded that the mathematical statistics which have proved to be useful or indispensable in the treatment of data possessing variation appear to be useful in the analysis of production problems.

A Method of Measuring Oil Pool Performance

By CARLTON BEAL, Consulting Engineer, Los Angeles; R. W. FRENCH, JR., Assistant to Vice President, Standard Oil Company of Ohio, Oklahoma City; and C. R. DODSON, Associate Professor, Petroleum Engineering, University of Southern California, Los Angeles

A study was made of 84 sandstone oil pools and 38 limestone pools in the U. S. Special forms were developed which revealed, for each field studied, the pool's performance including total area, behavior of gas-oil ratio, water cut, reservoir pressure, cumulative production and other data. It was found that depletion type sand reservoirs recovered an average of 33 barrels of oil per 1000 pounds per square inch drop in pressure per acre foot of sand above the bubble point, and 61 barrels of oil were recovered below the bubble point. In contrast, water drive sand reservoirs yielded 310 barrels of oil above the bubble point and 371 barrels of oil below the bubble point.

In limestone depletion type pools, 13.8 barrels of oil were recovered above the bubble point, and 53.6 barrels oil below the bubble point. In contrast, water drive pools recovered in excess of 650 barrels of oil above and below the bubble point.

The California Oil Outlook

By R. L. MINCKLER, Executive Vice President, General Petroleum Corporation, Los Angeles

Dislocation between supply and demand of crude oil and finished products in the western states has been increasing. This is due principally to the rapid increase in population since the war, increased mechanization of farms, growing demand for oil-heating facilities in areas not served by natural gas, and greatly increased demand by electric power generating plants and railroads for fuel oils.

Because the supply of coal is poor in the area, and sources of electric power are becoming fewer, oil has filled the gap in the increasing demand for sources of energy. New steam electric generating plants are being built and it is expected that demand for heavy oil will continue. Exports total only about 70,000 barrels per day, but this figure will be reduced when the East Indies again get on full production. Assuming that no major fields are discovered in California between now and 1950, it is estimated that by 1950 the supply of crude will fall short of demand by about 6000 barrels per day; by 1951, 64,000 barrels per day; and by 1952, 105,000 barrels per day. However, there is no prospect of an oil shortage, for there still remain several important sources of supply which may be developed before having to resort to importation of crude from other areas. Ultimate recovery may be increased by wider application of pressure maintenance. Production volume may be increased by resorting to secondary recovery in fields where it is practical. New production methods and techniques may be developed which will handle the heavy oil deposits known to exist in California areas. With the aid of new tools and methods, new stratigraphic traps and other lesser known types of accumulation may be found.

Financing of the extremely costly projects or importing that may be necessary to increase supplies of petroleum products remains one of the greatest problems of the oil industry and the only practical way is to plow back current earnings. This will require high profits but the public will have to realize it. Fortunately for the oil industry, higher earnings are being realized today and the supply and demand situation will support them.

Location of Points of Water Entry in Oil Wells

By D. SILVERMAN and A. R. BROWN, Standolind Oil & Gas Company, Tulsa

New techniques and equipment for locating the points of entry of salt water into oil wells are described. The equipment comprises a long pipe-like assembly carrying 10 pairs of electrodes spaced four feet apart. Conductivity of the fluid in the vicinity of each of the electrode pairs is continuously recorded at the surface through operation of surface-controlled solenoid operated switches. The assembly is lowered on tubing and placed opposite the section of the well to be studied. A conventional rod pump is used to produce the well, the pump inlet being placed below the lowest electrode pair. The well is conditioned by pumping out the salt water normally standing in the well and introducing fresh water into the annulus. When resistivity of the water in the well has been increased to the desired value, the inflowing fresh water is stopped and the drawdown operation is started. As the fluid head is lowered by pumping, fluids flow into the well and the entry of salt water is indicated by the change in resistivity of the fresh water opposite the zone of water entry. The process can be repeated as often as desired.

Data are given on the results of surveys made on a number of producing wells. Results of workovers made on the basis of some of the surveys also are given. Among the interesting results of the surveys are that approximately 50 percent of the wells tested showed intermediate instead of bottom water; and that nearly a third of the wells showed multiple-zone water production.

Experimental Production Projects and Exploratory Drilling at Elk Hills

By MAX C. EASTMAN and COMMANDER F. L. RUHLMAN, U. S. Naval Petroleum Reserve No. 1, Tupman, Calif.

Following the termination of the war, oil field operations in the Elk Hills Naval Petroleum Reserve were greatly curtailed, various experimental production projects were started, and a long range exploratory drilling program was inaugurated. From a wartime peak of 65,000 barrels per day production was reduced to the current rate of about 8000 barrels. This was considered sufficient to maintain an available source of crude which can be drawn upon during a na-

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HOTE EDSON ..... Beaumont
HOTEL BROWNWOOD ..... Brownwood
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HOTEL TEXAS ..... Fort Worth
HOTEL BUCCANEER ..... Galveston
HOTEL GALVEZ ..... Galveston
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JACK TAR COURT HOTEL ..... Galveston
MIRAMAR COURT ..... Galveston
HOTEL CAVALIER ..... Galveston
HOTEL PLAZA ..... Laredo
HOTEL LUBBOCK ..... Lubbock
HOTEL FALLS ..... Marlin
HOTEL CACTUS ..... San Angelo
HOTEL MENGER ..... San Antonio
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tional emergency, and at the same time permit the carrying on of experimental production projects.

Among the projects now being investigated are (1) protection of surface equipment on some 500 wells from damage by corrosion; (2) repair of wells which might damage the reservoir; (3) gas injection; (4) water encroachment; and (5) gravity drainage. In order to determine the extent of reserves in unexplored portions of the Naval Reserve, an explaratory program is being conducted. The shallow zone exploration is practically completed, but due to the complexity of the Stevens zone structure and the magnitude of oil discoveries so far made in the Stevens, exploration in that zone probably will be continued for another two years. The reserves of the Stevens zone are placed at about 250 million barrels. An important result of exploratory work so far has been establishing the fact that instead of a single long anticline, the Stevens zone includes at least three separate closures.

Apparatus for Determination of Volumetric Behavior of Fluids

By B. H. SAGE and W. N. LACEY, California Institute of Technology, Pasadena, Calif.

Because of the marked increase in the ranges of temperature and pressure encountered in underground hydrocarbon reservoirs, greater interest has been shown in the intensive characteristics of the fluids found in them. The authors describe new apparatus and method for determining the volumetric behavior of hydrocarbons at pressures up to 10,000 pounds per square inch and at temperatures between zero and 460° F.

Provision for measurement of both total volume and liquid-phase volume makes it particularly suitable for the equilibrium study of heterogeneous systems consisting either of simple mixtures or of complex field samples of hyrdocarbons. Drawings showing arrangement of the apparatus and cut-away sketches of level indicator, equilibrium cell and magnetic agitator drive are presented. In addition, detailed descriptions are given on the elaborate pressure balance and the electrical circuits involved in the temperature control apparatus. Estimated uncertainties of measurements made with the equipment in the procedures described are as follows: Total volume, 0.5 percent; liquid volume 0.005 cubic inch; temperature 0.2° F.; pressure 0.2 psi; and weight 0.2 percent.

Gas Group Elects

J. V. Pratt of Colby, Kansas, was elected president of the Kansas Liquefied Petroleum Gas Association at the annual convention in Wichita. Other officers: R. H. Mahnke, Wichita, executive vice president; Glen Humberg, La Crosse, vice president; and Eli Worden, Winfield, secretary-treasurer.

Stanolind Engineers Meet

Ways and means of drilling for and producing oil more efficiently was the keynote of a Houston meeting attended by 31 Stanolind Oil & Gas Company petroleum engineers. The group, headed by L. E. Elkins, chief production engineer, consisted primarily of engineers from the company's Gulf Coast Division which embraces the territory from the Rio Grande River to the Mississippi River.

New developments in fluid flow were presented by C. R. Holmgren, and R. F. Farris discussed drilling problems and their solution.

Engineers Elect

H. L. Pickens of Allis-Chalmers Manufacturing Company has been elected president of the Engineering Club of Oklahoma City, succeeding Ross Stuntz, with Cities Service Gas Company. Other officers include George E. Larason, Oklahoma Gas and Electric Company, first vice president; Earl Fox, Consolidated Gas Utilities, second vice president; and J. A. Moore, Westinghouse Electric Company, secretary-treasurer.

THE OIL MAN'S CALENDAR

DEC. 1- 5	American Society of Mechanical Engineers Annual Meeting, Chalfonte and Haddon Hall, Atlantic City, N. J.
3	Mid-Continent Oil & Gas Association, General Association, 30th Annual Meeting of General Board of Directors, Tulsa, 308 Tulsa Bldg.
4- 5	American Institute of Mining and Metallurgical Engineers, Annual Meeting, Texas Section, Texas A. & M. College, College Station.
4 -6	Interstate Oil Compact Commission, Oklahoma City, Biltmore Hotel.
11	Mid-Continent Oil & Gas Association, Louisiana-Arkansas Division, New Orleans, Roosevelt Hotel.
15-16	Mid-Continent Oil & Gas Association, General Association, Annual Ad Valorem Tax Forum, Jackson, Miss., Edwards Hotel.
1948 JAN. 14-15	American Association of Petroleum Geologists, Regional Meeting, St. Louis, Jefferson Hotel.
FEB. 15-19	American Institute of Mining and Metallurgical Engineers, Annual Meeting, New York, Pennsylvania Hotel.
MAR. 12-14	Texas Independent Producers and Royalty Owners' Association, Annual Meeting, Corpus Christi.
24-26	Natural Gasoline Association of America, Annual Meeting, Ft. Worth, Texas Hotel.
24-26	Southern Gas Association, Galveston, Texas.
24-26	American Petroleum Institute, Mid-Continent District, Wichita Kansas, Broadview Hotel.
APRIL 14-16	American Petroleum Institute, Southwestern District Meeting, San Antonio, Plaza Hotel.
21-23	National Petroleum Association, Hotel Cleveland, Cleveland
26-29	American Association of Petroleum Geologists, Society of Economic Paleontologists & Minerologists, Society of Exploration Geophysicists, Annual Meeting, Denver, Shirley-Savoy Hotel.
28-30	Liquefied Petroleum Gas Association, Annual Convention and Trade Show, Kansas City, Mo.
MAY 4- 5	American Gas Association, Natural Gas Department, Annual Spring Meeting, Houston, Rice Hotel.
6- 7	American Petroleum Institute, Pacific Coast District Meeting, Los Angeles, Biltmore Hotel.
15-22	International Petroleum Exposition, Tulsa.
JUNE 30 July 2	American Petroleum Institute, Eastern District Meeting, White Sulphur Springs, W. Va., Greenbrier Hotel.
JUNE 30 July 3	Canadian Gas Association, Annual Convention, Jasper, Alberta, Jasper Park Lodge.
SEPT. 15-17	National Petroleum Association, Atlantic City, N. J., Hotel Traymore.
OCT. 4- 9	American Gas Association, Atlantic City.

Nomads Chapter monthly meetings: LOS ANGELES, second Wednesday, Jonathan Club. HOUSTON, second Monday, Houston Club. NEW YORK, first Monday, Louis Sherry's. TULSA, third Wednesday, Hotel Tulsa.

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Men in the Industry NEWS

T. M. Martin

T. H. Barton

Col. T. H. Barton, president of Lion Oil Company since 1929, has been elected chairman of the board and has been succeeded as president by **T. M. Martin,** vice president since 1929 and executive vice president since 1939. A native of Falls County, Texas, Colonel Barton was a pioneer in the development of the petroleum industry in Arkansas. After organizing the Natural Gas and Petroleum Corporation in 1921, he served as president and director of the successor Natural Gas and Fuel Corporation, a position he left to become president of Lion Oil Refining Company, which was renamed Lion Oil Company in 1945. Martin has been active in the petroleum industry since 1923, when he was in the oil brokerage business at Chicago. Later he was general manager of Diamond Petroleum Company at Louisville, Ky. In 1929, at the age of 34, he was elected a director and vice president of the Lion company.

»

F. Julius Fohs, consulting geologist of Houston, gave a series of lectures at the Geological Department of Columbia University on "Oil Finding, Practice and Theory," during October, and is back in Houston. He will return to New York to address the Eastern Section of the AAPG on the "Oil Reserve Provinces of Russia" December 10.

»

D. E. Carr has joined the Research Department of Phillips Petroleum Company at Bartlesville, Okla. He formerly was with Union Oil Company as director of research.

»

Whitney J. Dufrene, Producing Department employe of The Texas Company, was awarded the National Safety Council President's Medal for having saved the life of the man who had taught him first aid. **E. E. Millet,** a pumper on the company's lease at Paradise, La., was injured by lightning and revived by Dufrene.

»

Rush Greenslade, vice president of Gulf Oil Corporation, was made an honorary member of the Osage tribe in a ceremony conducted by **Chief Fred Lookout.**

»

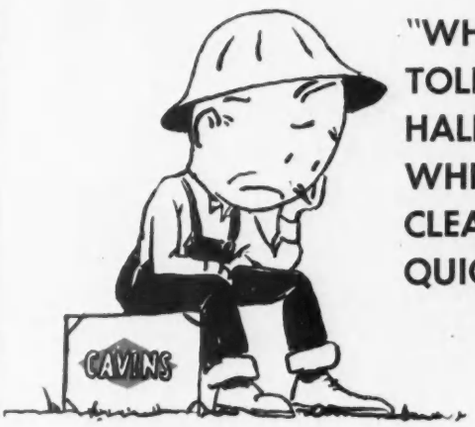
Dan Fore, Jr., has joined the Research Department staff of Phillips Petroleum Company in Bartlesville, Okla.

E. F. (Tex) Underwood, wholesale sales manager of Skelly Oil Company at Kansas City since 1934, has resigned to become executive vice president of Graco Oil & Refining Company with headquarters at Denver. Underwood had been with Skelly since 1926 and served in all branches of the sales organization and in various division posts prior to being named head of wholesale sales for the entire Skelly organization.

Dick Wegener, formerly with Halliburton Oil Well Cementing Company, Duncan, Okla., has become an independent operator and is starting his first venture in Seminole County, Oklahoma.

»

Harry D. Hancock, president of Gas Advisers, Inc., New York, has been presented the distinguished service award by the American Gas Association.



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"Man, there was a truck-load of sluffed-off sand in that bore! How that well ever produced is a mystery to me. The sand finally stopped coming after about two days of bailing and when we got everything buttoned up he ran a swab in the hole. He hit that baby about two licks and she *really took off* . . . tubing pressure went right on up where it belonged and he started screaming for small chokes. After he had her settled down, he gave us a funny sort of a look and said 'Maybe you'd better set up on No. 21 while you're out here . . . I think it needs some of the same medicine.'"

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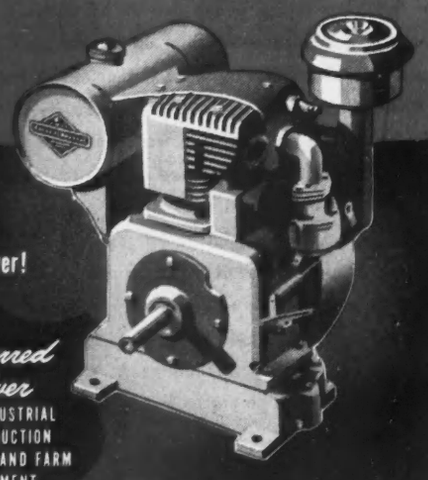

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MEN IN THE INDUSTRY NEWS

M. A. Abernathy

A. D. Greene

A. D. Greene and **Ed Parkes** were chosen vice presidents of United Gas Pipe Line Company and **M. A. Abernathy** was named a director of United Gas Corporation. Greene, chief engineer for 17 years, takes over direct operation of the pipe line company. Parkes, in charge of gas gathering lines for ten years, becomes head of a new gas supply department. Abernathy, who was named a vice president of the corporation in May, is in charge of all transmission operations and will assist President N. C. McGowen in distribution operations. As director, he succeeds **George T. Naff,** who resigned recently to enter private law practice. Other shifts of executive personnel advanced **D. R. Pflug** to chief engineer and **D. D. Dillingham, Jr.,** and **L. C. Poindexter** to general pipe line superintendents. The latter two will handle gathering and transmission line operations in newly-formed western and eastern divisions of the company, Dillingham in Texas, and Poindexter in Louisiana, Mississippi, Alabama, and Florida.

Ed Parkes

»

Joseph P. Walsh, general counsel of Sinclair Oil Corporation, has been appointed to membership on the American Petroleum Industries Committee of The API. He succeeds **P. C. Spencer,** who resigned from the committee because of the additional responsibilities imposed upon him when he was made president of Sinclair Refining Company.

»

F. W. Richards of the Shell Production Department has retired after 28 years' service. He was the general manager of Sarawak oil fields, and also served in Venezuela before returning to London in 1931 to the Shell London office.

»

W. J. Darby, petroleum engineer, will join the firm of Shurman & Kirkwood, Inc., Fort Worth, as tax consultant on oil matters.

»

Kent K. Kimball, consulting geologist, Tulsa, has been appointed executive secretary of the scientific and technical committee of the International Petroleum Exposition in Tulsa May 15-22 next year. Kimball has taken an active part in some phase of the exposition's program since 1927.

MEN IN THE INDUSTRY NEWS

Franklin W. Bates has been appointed West Coast counsel for Arabian American Oil Company and Trans-Arabian Pipe Line Company. Bates has been associated since 1937 with the San Francisco law firm of Pillsbury, Madison and Sutro, whose clients include the Standard Oil Company of California, one of the parent companies of Aramco and TAPline. Bates' appointment follows the selection of **George W. Ray, Jr.**, as general counsel for Aramco and TAPline. Ray formerly was with The Texas Company.

Franklin W. Bates

»

E. Charles Patton, Jr., petroleum engineer, Magnolia Petroleum Company, Dallas, is the 1948 recipient of the Raymond Memorial Award of the AIMME. The award is made annually to the author whose technical paper is the outstanding original contribution of both scientific and practical value. The competition is restricted to authors under 33 years of age and includes papers on mining and metallurgy as well as petroleum production. Patton, who is a native of Dallas, an ex-student at SMU, and a graduate of the University of Texas, will receive the award at the Institute's Annual Meeting at New York in February. His paper is entitled "Evaluation of Pressure Maintenance by Internal Gas Injection in Volumetrically Controlled Reservoirs.

»

Dan O. Howard, geologist with the Oklahoma Conservation Department, has resigned to join Warren Petroleum Corporation as field engineer in the Southwestern states.

»

William G. Skelly, president of Skelly Oil Company, Tulsa, was elected to the board of Oklahoma Natural Gas Company, succeeding the late **Henry N. Greis.**

»

A. P. Frame is the president of Cities Service Research and Development Corporation, a new firm charged with direction of all the research activities which have been carried on by individual operating companies of Cities Service Company. Organization of the company was the first step in the centralization and expansion of the research and development activities of Cities Service. **W. Alton Jones**, president of Cities Service, is chairman of the board of the new corporation, and **C. L. Mateer** is vice president.

»

A. D. (Dee) Griffith and **George (Red) Rosen** have organized the firm of Griffith and Rosen, petroleum consultants, at Oklahoma City. Both are geological graduates from the University of Nebraska. Griffith formerly was farm boss and Rosen was field engineer for Stanolind Oil & Gas Company in the West Edmond area.

Arthur F. Bridge, vice president and general manager of Southern Counties Gas Company since 1939, was elected president and general manager. **F. S. Wade**, who has served in a dual capacity since 1939 as president of both Southern California Gas Company and Southern Counties Gas Company, retired from his position in the latter organization. **Guy W. Wadsworth** was elected a member of the board of directors and vice president and assistant general manager of Southern Counties Gas Company. **F. A. Hough**, executive engineer and a director of Southern Counties gas, was made a vice president.

»

Jodie Bob George of the safety department of Sinclair-Prairie Oil Company, Tulsa, has accepted a position as head of the safety department of The California Company at New Orleans.

»

C. M. Linehan has resigned from the geological department of Standard Oil Company of Texas at Wichita Falls, Texas, to become district geologist at Midland, Texas, for The Superior Oil Company of California.

»

L. B. (Mac) Finlayson, former construction superintendent for Midwestern Engineers, Tulsa, recently embarked for Saudi Arabia where he will be construction superintendent on the Saudi Arabian Pipe Line. He expects to remain in that country 2½ years.

»

Milton W. Lewis, consulting geologist and petroleum engineer, has taken over the post vacated by **Dr. E. K. Soper** as consulting geologist and petroleum engineer for the California State Lands Commission, Los Angeles. Lewis still maintains his consulting offices in the Petroleum Building, Los Angeles.

»

Harry L. King, western scout for Continental Oil Company, has established headquarters at Bakersfield, Calif.

»

Valerie True, James P. Gore and **Winifred E. Gore** have organized the Drillers Fuell Supply, Inc., capitalized at $30,000 and with headquarters at Oklahoma City.

»

Richard M. Riggs, Tulsa, has joined the geological department of Stanolind Oil-Gas Company at Oklahoma City.

»

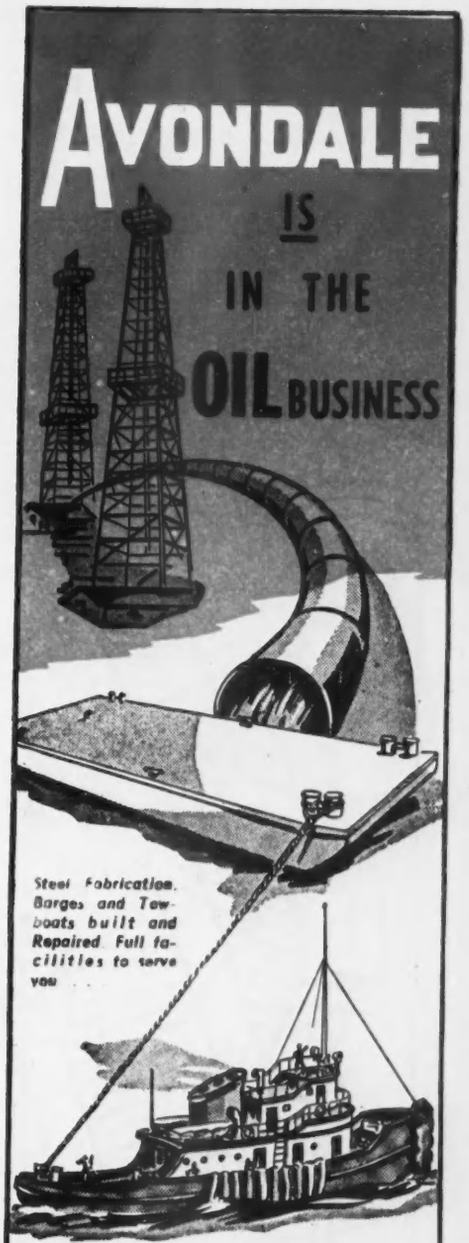
A. Lynn Porter has joined Tennessee Gas Transmission Company as internal auditor. He formerly was with Magnolia Petroleum Company of Beaumont, Frazier and Torbet in Houston, and Boney and Porter in Houston.

»

Herbert F. Beardmore, Tulsa, has resigned as chief petroleum engineer of Barnsdall Oil Company to take charge of production for Warren Oil Corporation at Houston. **William L. Horner**, head of Barnsdall's secondary recovery division, succeeds Beardmore.

»

J. Walter Leonard, president of Leonard Pipe Line Company, was named chairman of the board and **David Beach** was promoted from executive vice president to president.



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Frank Strickland, oil producer and drilling contractor, has opened an office at Mount Vernon, Ill.

»

Delbert J. Costa, formerly of Wichita, Kansas, has been named district geologist at Oklahoma City for The Superior Oil Company of California.

»

William L. Daoust has been promoted to chief geologist for the oil and gas section of the department of conservation of Michigan, succeeding the late **F. R. (Gus) Frye.**

M. MacIver was named vice president of California Texas Oil Company, Ltd., in charge of fiscal matters. He succeeds the late **William Kunstadter,** who was vice president and treasurer. MacIver joined Caltex in 1938 and was named comptroller in 1946.

»

James R. Brown, head of the land department of The Vickers Petroleum Company, has been elected a vice president. He joined the firm in 1921.

R. C. Gunness

T. H. Rogers

R. C. Gunness has been promoted to manager of the research department of Standard Oil Company (Indiana) and **T. H. Rogers** has been promoted to director of research. **J. K. Roberts,** general manager of research, who recently was made a director of the company, will continue to have general supervision over all research department activities. Dr. Gunness received his doctor's degree in chemical engineering from Massachusetts Institute of Technology in 1936 and served as assistant professor in the chemical engineering department at M. I.T. for two years before joining the research staff of Standard Oil Company (Indiana) in 1938 as a group leader. In 1945 he was made associate director of research. Dr. Rogers received his Ph.D. from Johns Hopkins university in 1917. He served in the chemical warfare service during World War I and joined the Standard of Indiana research staff in 1922. He became an associate director of research in 1938.

»

E. W. Berlin, Scarsdale, N. Y., has been named head of the Producing Department of Standard-Vacuum Oil Company. He succeeds **H. W. McCobb,** recently elected to the board of directors. Berlin graduated from the University of California at Berkeley with a B. S. in petroleum engineering in 1926. After experience in the California producing fields, he joined Nederlandsche Koloniale Petroleum Maatschappij in 1929 and worked in the Netherlands Indies until the war began. During the war he served as area petroleum officer for the CBI theater. He joined Standard-Vacuum's New York staff in January, 1946, as assistant head of the Producing Department.

»

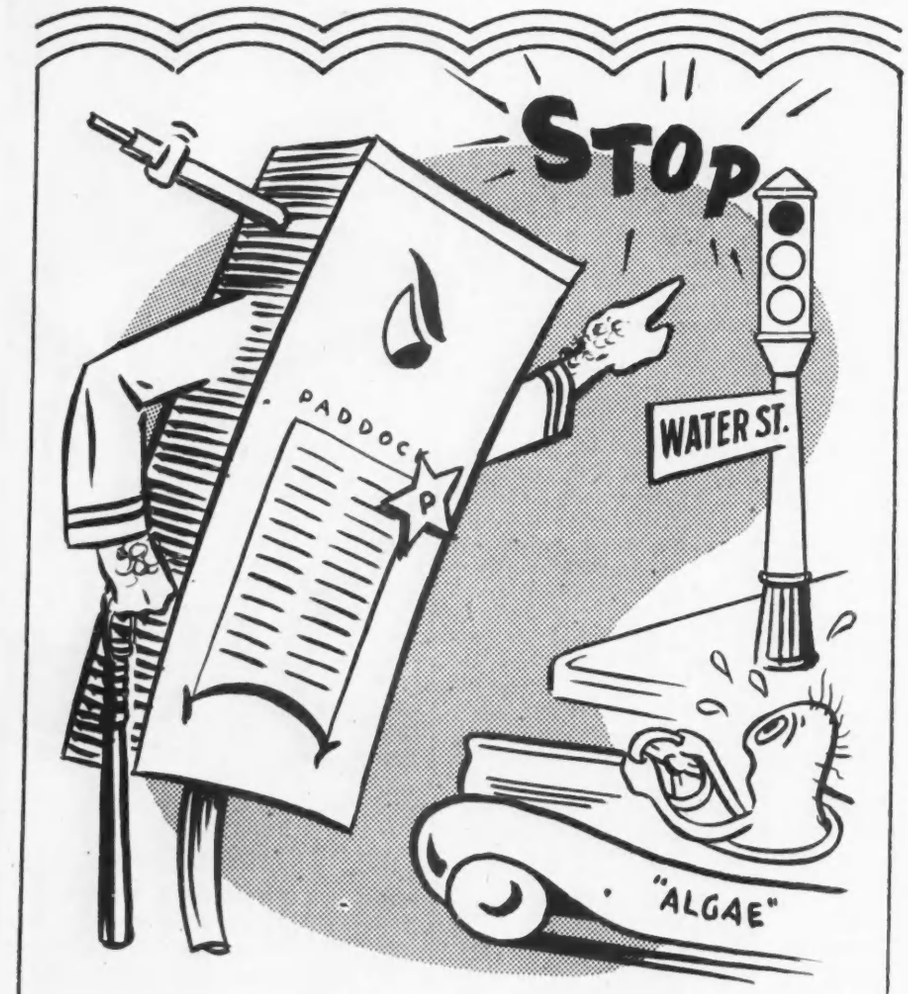
A. C. Stailstad, director for Stanolind Oil Purchasing Company, was elected vice president. **M. M. Luther,** director, was made director of accounting and finance. **Ralph W. Boyd** was elected comptroller to succeed Luther. **T. E. Martin** was chosen chief accountant in charge of oil accounting. **D. A. East** was named chief accountant in charge of financial and tabulating accounting.

»

J. M. Taylor, who has been district manager at Houston, has been transferred to the home office at Oklahoma City, where he will be special representative.

»

C. L. Braswell, former city sales representative at Houston, has been transferred to Hobbs, N. M.



The PADDOCK High-Capacity CHLORINATOR stops that algae—keeps water systems and cooling towers from getting fouled up with destructive bacteria. The Paddock Chlorinator can handle up to 1,000 pounds per 24 hours within 4% positive control. No float boxes or float valves to need replacement or repair. All parts of silver, plastic or glass. Effective and economical. Stop water problems with a Paddock Chlorinator.

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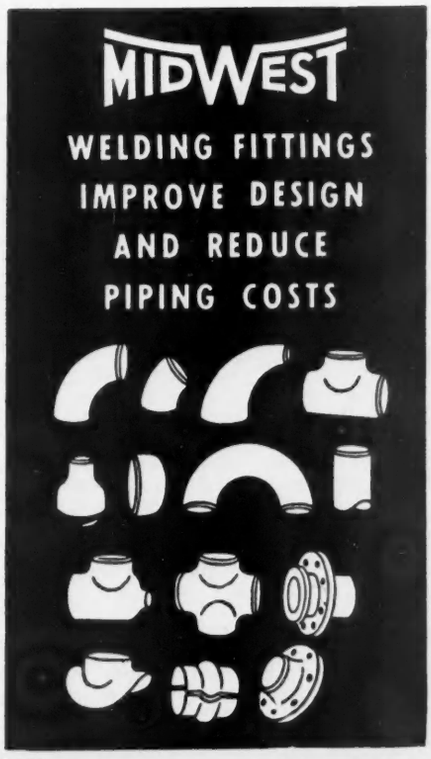

Don't bother to count 'em. Your time's too valuable. And besides, one quick glance will tell any refinery or pipe line man that Midwest makes an almost endless variety of welding fittings. Any of these—in the proper wall thickness and material—can be ordered thru your conveniently located Jones & Laughlin Supply store.

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MEN IN THE INDUSTRY NEWS

Transfers

W. A. (Bill) Clark, division engineer, Producing Department, Pacific Coast Division of The Texas Company, to Foreign Producing Operations as assistant manager, with headquarters in New York City. **H. O. Woodruff** replaced Clark as acting division engineer, and **O. W. Chonette** became acting district engineer, Los Angeles Basin District. **R. M. Morrison,** general purchasing agent of The Texas Company since 1944, named manager of the Purchasing Department, succeeding **R. S. Hatch,** now with Arabian American Oil Company. **Philip Hauck** succeeded Morrison as general purchasing agent. **W. G. Taylor** replaced Hauck as divisional purchasing agent at Chicago. **F. G. Schlemmer** of Los Angeles became Northern Divisional purchasing agent at New York to succeed Taylor. **M. E. Hankins** replaced Schlemmer as assistant purchasing agent at Los Angeles. **E. R. Walls,** supervisor of The California Company's Southern Division exploration for nine years, to the new staff position in the office of the company's board chairman in San Francisco. He was succeeded in New Orleans by **L. I. Brown. C. L. Ware,** scout for Phillips Petroleum Company, from Wichita Falls, Texas, to Durango, Colo. **F. A. Nelson,** senior geologist for Shell Oil Company, to the regional staff to represent the Tulsa area. **C. E. Tabor,** formerly on the regional staff, to senior geologist, Oklahoma City Division. **James E. Wilson,** regional staff, to district geologist, at Wichita Falls. **H. E. Rankin,** former senior geologist at Oklahoma City, to head the Central Division.

»

W. H. Miller, assistant general manager of sales for the Central Division of Standard Oil Company (Indiana), promoted to assistant general manager, sales promotion, in the general sales department. **F. J. Swindell,** assistant general manager of sales for the Western Division, transferred to the Central Division to succeed Miller, and **W. C. Kniefel,** assistant general manager of sales for the Rocky Mountain Division, transferred to Western Division to succeed Swindell. **W. B. Egbert,** manager at Denver, promoted to assistant general manager of sales for the Rocky Mountain Division to succeed Kniefel; **T. J. Wolfe,** assistant manager at Denver, succeeded Egbert as manager at Denver; and **A. K. Smith,** sales manager at Des Moines, Iowa, succeeded Wolfe as assistant manager at Denver.

»

B. W. (Bubba) Haywood, zone agent for Gulf Oil Corporation, with headquarters at Tampa, Fla., to Shreveport as assistant to **General Agent Joe T. Goodman,** of Gulf Refining Company. Prior to Haywood's assignment in Florida, he was connected with the East Texas zone office of Gulf Oil Corporation, located at Tyler, Texas, as assistant zone agent. **George E. Carver,** geologist with Kerr-McGee Oil Company, from Oklahoma City to Borger, Texas. **Robert C. Martin,** scout for Lion Oil Company at Jackson, Miss., to the land department there. **J. R. Keeling** from El Dorado, Ark., to Jackson as scout.

MEN IN THE INDUSTRY NEWS

Olaf F. Sundt of Houston, U. S. petroleum attache at Lima, Peru, to Paris, France, in the same capacity.

⌄

G. L. Mann, superintendent, Warren Petroleum Corporation, Monument, N. M., to Graham, Okla. **Gordon W. Hartis,** Gulf Producing Company engineer at Smackover, Ark., to Kansas City, Mo. **E. E. Whitworth,** Shell Oil Company superintendent at South Bend, Ind., to Kilgore, Texas. **L. A. Tarbet,** Standard Oil Company of California geologist at San Gabriel, Calif., to San Francisco. **J. M. Samuel,** Stanolind Oil & Gas Company engineer at Fort Worth, to Tulsa. **Ralph L. Thom,** Magnolia Petroleum Company foreman at Ocean Springs, Miss., to Kilgore, Texas.

⌄

B. H. C. Stover, Columbia, Miss., Hub District chief clerk for Humble Oil & Refining Company's Production Department, to the Grand Isle District, Harvey, La., as district chief clerk. **J. D. Cole,** chief clerk of Paradis District, Paradis, La., replaces Stover. **O. J. Aucoin,** district chief clerk for the North Crowley District, Crowley, La., to the Paradis District as chief clerk. **Jack Pierce,** assistant district chief clerk for the Bayou Sale District, Franklin, La., to the North Crowley District, Crowley, La., and promoted to district chief clerk. **C. C. Pyle,** assistant district chief clerk of the North Crowley District, to the Bayou Sale District, Franklin, as assistant district chief clerk. **F. G. Henry,** Hawkins District chief clerk, Hawkins, Texas, to the North Crowley District and promoted to assistant district chief clerk. **Ollie Canion,** general clerk, from the civil engineering division in the Houston office to the Grand Isle District, Harvey, La., as assistant district chief clerk. **G. W. Jones,** assistant chief clerk, from the Houston trucking terminal to the material section of the production operating department, Houston.

⌄

George W. Waite, who formerly operated as an independent consulting geologist, has become associated with **Thomas H. Allen.** Their offices are in the Union National Bank Building in Wichita, Kansas. Waite was in the Marine Corps from 1942-1946.

⌄

Frank G. Evans, formerly with Shell Oil Company, Inc., is now associated with **Carleton D. Speed, Jr.,** Second National Bank Building, Houston, in the development of oil properties. During the 20 years Evans was with Shell, he specialized in field mapping, geologic research and photogeology.

⌄

Dr. Donald G. Zink, formerly director of technical development of U. S. Industrial Chemicals, Inc., has been named superintendent of the chemical products department of Stanolind Oil & Gas Company, at Tulsa. Dr. Zink attended Louisiana State University and Johns Hopkins University, receiving his Ph.D. degree in 1934. He joined U. S. Industrial Chemicals, Inc., where he was director of technical sales and products development, and director of technical development.

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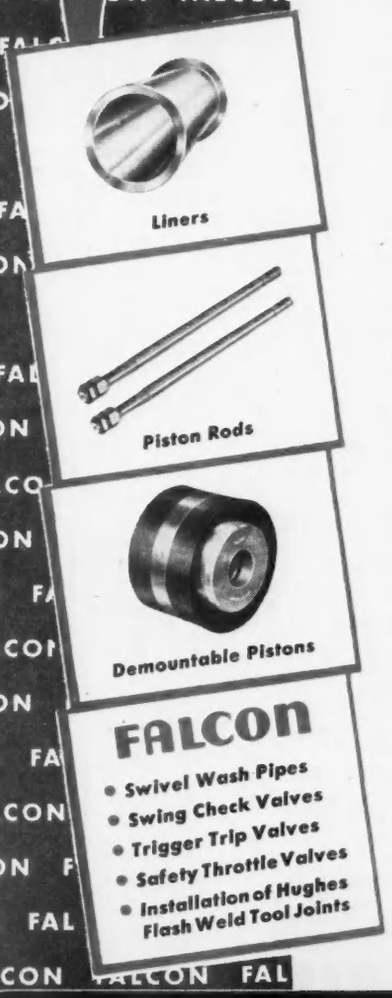

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If a politician were not above letting his mind dwell on it, it would be a situation to warm the cockles of the heart. Relief for starving millions! Votes lined up like soldiers! As a matter of fact the possibilities are so interesting and exciting that it really doesn't make too much difference whether we lend or donate. It would be so much trouble to go about this thing banker-like, with a view to getting our money back with interest. Only Finland pays, anyway. What the hell!

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MEN IN THE INDUSTRY NEWS

Dr. John R. Bates

Dr. John R. Bates, former assistant to Sun Oil Company's vice president in charge of manufacturing, has been appointed director of research and will head the new Research Department. The department was set up as the initial step toward consolidation of most of the company's scientific activities into a proposed Science Center at Newton Square, Penn. He will be assisted by **J. Bennett Hill,** now manager of the development division of the Manufacturing Department; **Dr. John M. Pearson,** now director of physical research and development of the Production Department; and **Stewart S. Kutrz, Jr.,** manager of the experimental division, Manufacturing Department.

»

John W. Botawright has been appointed general manager of the distribution economics department of Standard Oil Company (Indiana). He formerly headed the combined sales research and budgeting departments. **D. S. Warning** has been appointed manager of the commercial research division of the distribution economics department, with responsibility for sales budgets, general economic studies, problems of product supplies and consumer and sales research reports. **R. M. Eberly** has been appointed manager of the coordinating division of the distribution economics department. He will be responsible for economic studies pertaining to manufacturing and transportation problems, and sales department expense and profit analyses.

»

Sir Kenneth Harper has been appointed to the board of the Anglo-Iranian Oil Company. He has long been associated with the Burmah Oil Company, and became general manager in the East in 1939, and a director in 1937.

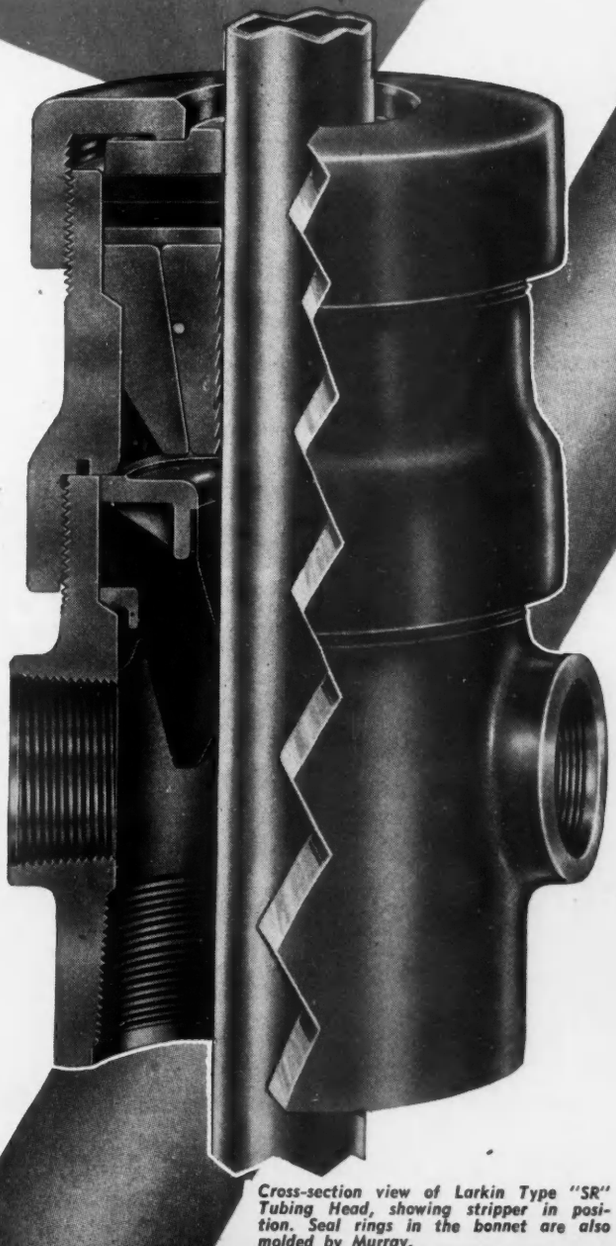
»

G. C. Wigham of Great Britain has on medical advice resigned his directorships of Burmah Oil and Anglo-Iranian companies. He has been a director of the former since 1919, and of the latter since 1925.

»

F. H. Braybrook has been appointed head of the Management of Industrial Development set up by Shell to advise its managing directors on world-wide technical developments affecting the petroleum chemical industry, and to be responsible for long-range planning of the group's industrial development. Previously manager of the Chemical Products Department, Braybrook will have as his general assistant **W. F. Mitchell** (previously sales manager of Shell in Canada). **Dr. W. S. Matthews** will head the division of Industrial Development Planning, **A. V. Billinghame** and **L. W. Leyland Cole** will be jointly in charge of the Division of Market Research, and **A. D. Koeleman** will be responsible for patent policy.

Murray molds the LARKIN STRIPPER



Cross-section view of Larkin Type "SR" Tubing Head, showing stripper in position. Seal rings in the bonnet are also molded by Murray.

You'll find Larkin Tubing Heads in oilfields everywhere . . . on flowing, pumping and gas lift wells. One reason for this widespread acceptance is the rugged, slow wearing, oil resistant, self-lubricating neoprene tubing stripper which serves as a blowout preventer and oil saver while tubing is being worked.

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Murray Rubber

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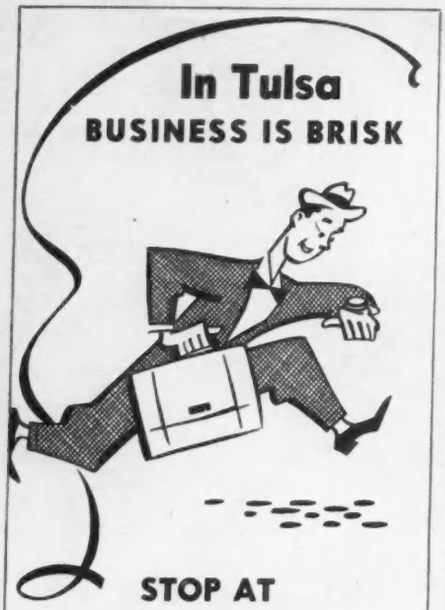

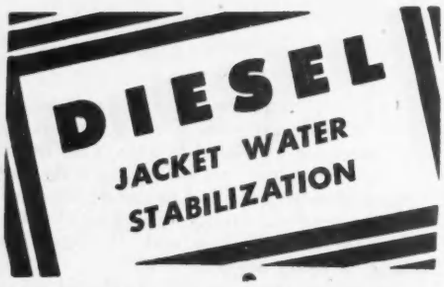

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BE SURE TO CHECK

The Trading Post?

PAGE 327

MEN IN THE INDUSTRY NEWS

R. Otis McClintock, president of First National Bank and Trust Company, Tulsa, was elected a director of Mid-Continent Petroleum Corporation, succeeding the late **Henry N. Greis.** McClintock began his association with the bank in 1918 as a director and in 1928 he was elected president. A former vice president of Gypsy Oil Company, he held a similar position with Philmack Oil Company and was a vice president and director of Independent Oil & Gas Company when that firm was consolidated with Philmack.

R. Otis McClintock

»

Eugene Gifford Grace, chairman of the board, Bethlehem Steel Corporation, will be awarded the AIME's Charles F. Rand Gold Medal for "distinguished achievement in mining administration." The award will be presented at the February meeting of the Institute in New York City. In presenting Grace's name to the board of directors, **E. DeGolyer,** chairman of the Charles F. Rand Foundation Award Committee, offered the following citation: "For distinguished leadership in the administration of all phases of a large and complex industrial enterprise; for profound influence on the growth and health of the American iron and steel industry."

»

M. H. Banks of Cos Cob, Conn., was named manager of employe relations for Standard-Vacuum Oil Company, succeeding **J. J. Waters,** who is retiring. Banks joined the organization in 1923 and was assigned to the India marketing division, where he served for 22 years. He became manager of the Colombo, Ceylon, Office in 1944 and the following winter the company recalled him to New York for a special wartime assignment, after which he was made assistant manager of employe relations in June, 1946. Waters has been manager of employe relations since 1944. He joined Standard-Vacuum in 1917 and was stationed in the Netherlands Indies. During his 25 years there he rose to president-director of Standard-Vacuum Sales Company. Returning to the U. S. shortly before the Japanese invasion of the Indies, he served for two years as director of employment for the American National Red Cross and rejoined Standard-Vacuum in 1944.

»

Queen Wilhelmina recently visited the Coevorden field. The Queen was welcomed by **V. T. W. Van Hasselt,** managing director of the Bataafsche; **J. L. Chaillet,** production administrator; and **C. D. Doornik,** field manager. The Queen, who showed great interest in the drilling operations, ascended to the drilling platform of well S. 33, which had reached a depth of 2500 feet and was about to be put into production.

Robert W. Pack was named director of production for Sun Oil Company. Pack, formerly general manager of the company's Gulf Coast Division, will move his headquarters from Beaumont to Philadelphia around January 1. He has been a member of the board of directors since March. **John G. Pew,** vice president in charge of production, announced the creation of a three-member management committee to succeed Pack in the Gulf Coast Division. They are **P. S. Justice,** head of land and geological operations; **Donelson Caffery,** manager of supply and transportation; and **Joiner Cartwright,** general counsel. All have headquarters in Beaumont.

Robert W. Pack

»

A. W. Walker, petroleum production engineer with Stanolind Oil & Gas Company for past 16 years, has been appointed assistant professor at the University of Tulsa, College of Engineering, and will instruct in the production engineering branch of the college under **Prof. Carroll V. Sidwell.** A graduate of the Missouri School of Mines, Walker also instructed in mathematics while completing his graduate work there in 1926-27. Before returning to Missouri School of Mines he spent a year in the oil fields in Venezuela. He joined Stanolind in 1931.

»

S. C. Mackenzie, who was for 17 years on the drilling staff of Anglo-Iranian Oil Company, and subsequently with Trinidad Leaseholds, has been appointed field engineer to Britain's Oil Well Engineering Company, a newly created post designed to insure closer liaison between the company and the users of their equipment.

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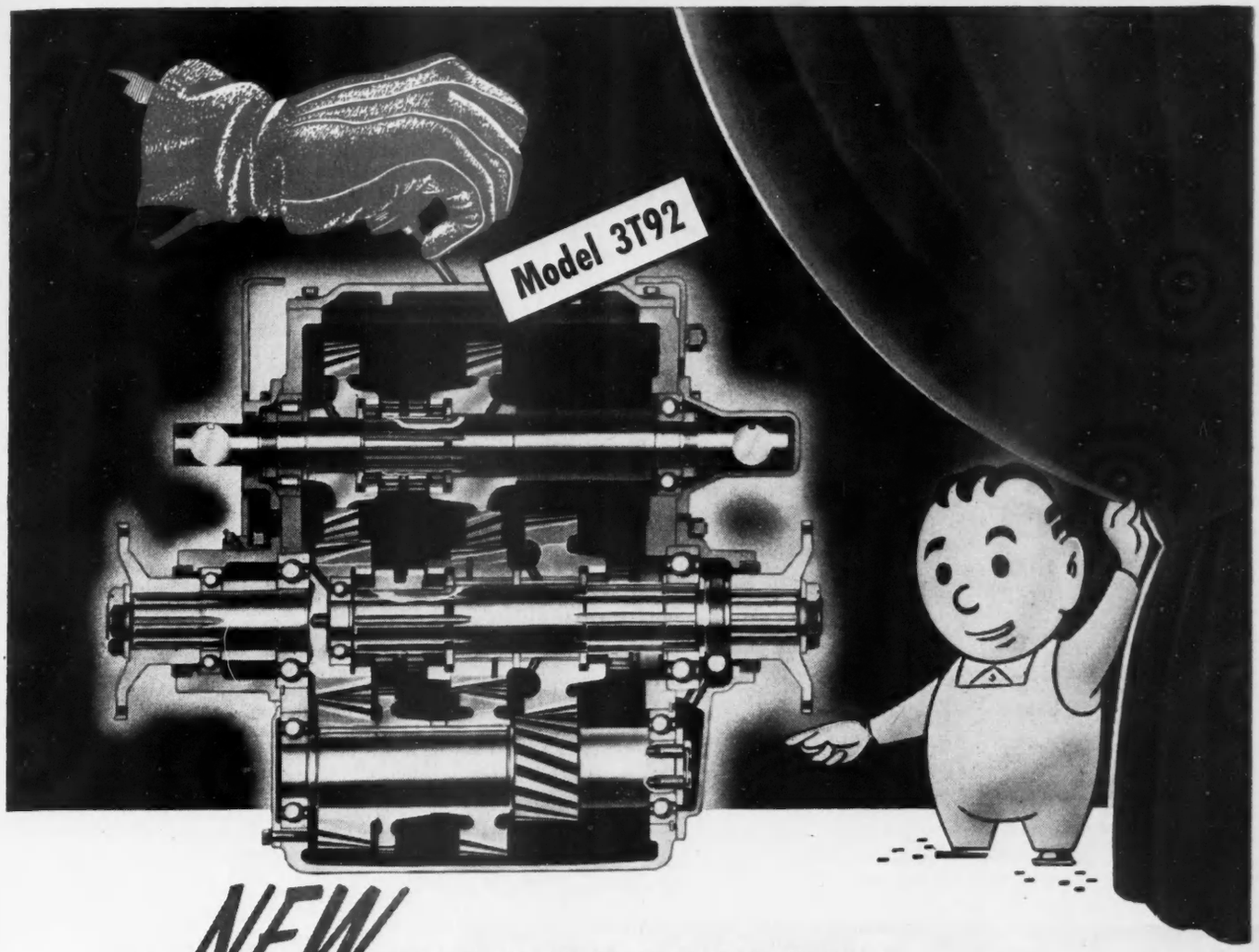

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The Model 3T92 Fuller Auxiliary Transmission takes its place in the Fuller line after three years of thorough testing in the field. It offers you the usual characteristics of Fuller Transmissions and Auxiliaries . . . including superior, quiet performance and long wear-life.

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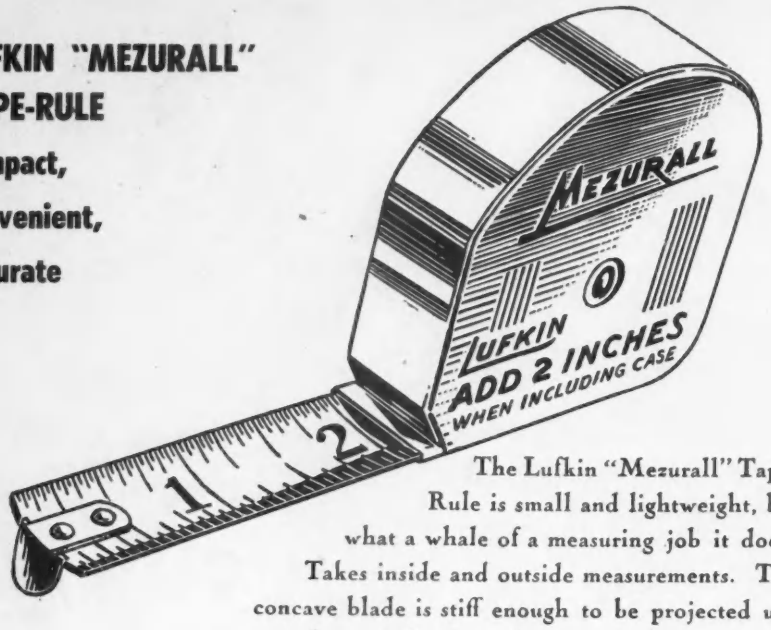

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4 CYL. V-TYPE
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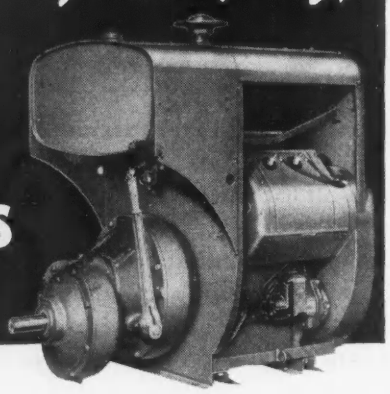

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Compact V-type design simplifies installation on a great variety of equipment and efficient AIR-COOLING takes care of all cooling problems . . . at any season, in any location.

Heavy-duty engineering features include: Tapered roller main bearings, dynamically balanced crankshaft, mirror-finish crank-pins, honed cylinders, and molybdenum iron valve seat inserts. High tension rotary type outside magneto is equipped with Impulse Coupling for quick, easy starting in any weather.

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DEATHS

Everit J. Sadler, 68, Scarsdale, N. Y., who retired in 1942 as vice president and a director of Standard Oil Company (N. J.), died at New Orleans after a week's illness. He entered the U. S. Naval Academy in 1895, went out with the fleet for the Spanish - American War, then returned to the Academy and graduated in 1899. After three years as a Naval officer, he entered the Mid-Continent oil fields. In 1906 he joined the Jersey company through the Prairie Oil & Gas Company. His first big job was in 1909, when he was made managing director of the Romano Americana Company in Roumania. When the U. S. entered World War I he again entered the Navy, but because of his experience in the petroleum industry, he was sent to Mexico to increase production. In 1919 he was named head of the foreign producing department of the Jersey company. In 1920, just 15 years after he was skinning mules in the Kansas oil fields, he was named a director. In 1928 he became president of Creole Petroleum Corporation, and in 1930 he was elected vice president of Standard Oil Company (N. J.).

Everit J. Sadler

»

Merton T. Archer, director of research for The National Supply Company plant at Torrance, Calif., and a pioneer in the development of equipment for the petroleum industry, died October 26 at Los Angeles. A native of Pittsburgh, Archer graduated in mechanical engineering from Carnegie Institute of Technology in 1910. During the war, he was with the Army Ordnance Ferrous Metallurgical Advisory Board as a member of the Subcommittees on Gun Forgings and Cast Armour. In 1945, he went to Chunking with the Donald Nelson mission as a consultant on metallurgical phases of China's war effort. He recently returned from a four-month survey of oil field operations in South America.

»

Edward H. Mueller, former treasurer of Shell Pipe Line Corporation, died at St. Louis, Mo. He had been on leave of absence due to ill health since November, 1946. Born in Findlay, Ohio, Novem 1, 1904, Mueller had been a resident of Houston since 1938. He joined the Shell organization in 1923 as voucher clerk in the St. Louis office, serving later in various capacities in St. Louis, Dallas, and Houston, before becoming treasurer for the Shell Pipe Line Corporation in 1940.

»

Ross M. Edgerton, 49, sales manager for Thilenius Equipment Company, Tulsa, died October 30 after several weeks' illness. A Tulsa resident for ten years, he formerly was an engineer with Sinclair-Prairie Oil Company.

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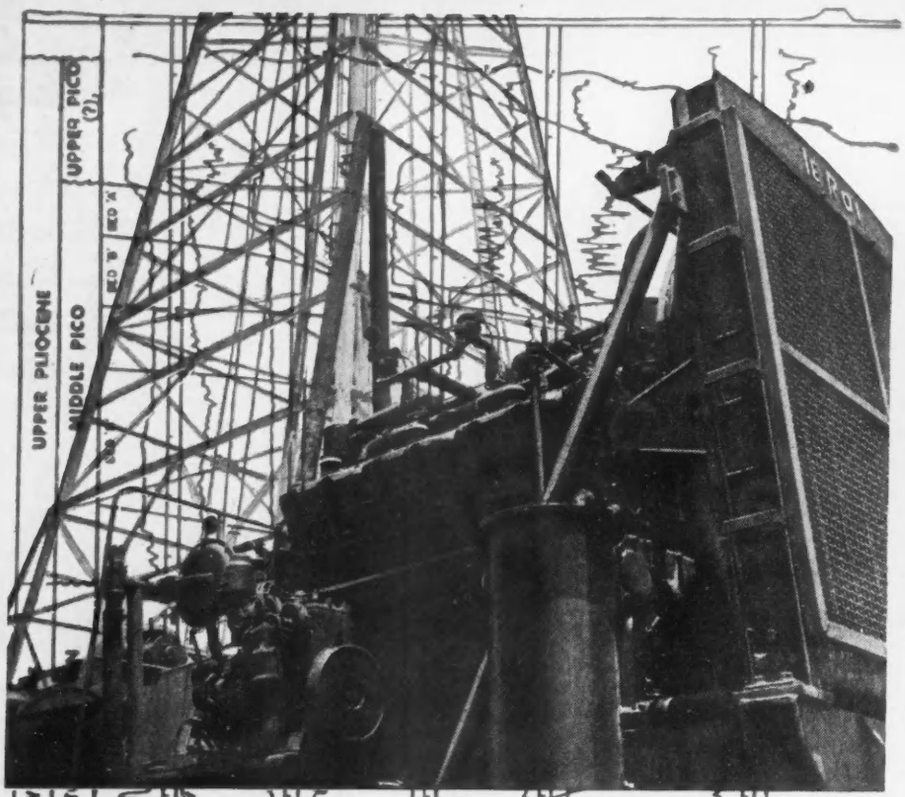

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Southern Engine and Pump Company — Houston, Kilgore, Edinburg, Dallas, San Antonio, Texas, and Lafayette, Louisiana.

North & West Texas, New Mexico
General Machine & Supply Co. — Wichita Falls, Odessa, Lubbock, Texas.

Kansas
Carson Machine and Supply Co.—Great Bend

Illinois — Western Kentucky
Western Machinery Company — Centralia, Illinois and St. Louis, Missouri.

LE ROI MILWAUKEE

Michigan
Hafer Engine Co. — Reed City

Rocky Mountain Area
Industrial Power Units, Inc. — Casper, Wyoming.

Northern Louisiana & Mississippi
Ingersoll Corporation — Shreveport, Louisiana, and Jackson, Mississippi.

West Coast
Le Roi-Rix Machinery Co. — Los Angeles, Calif.

Appalachian Area
Lloyd, Smith Company — Bradford, Penn.
P. C. McKenzie Co. — Pittsburgh

Canada
Drilling Supplies, Ltd. — Calgary, Alberta

Complete Sales and Service Facilities

P-90

DEATHS

John E. Green, Jr.

John E. Green, Jr., 67, general attorney for Gulf Oil Corporation, died November 8 at Houston of injuries suffered in a fall from a horse. A graduate of Southwestern University, Georgetown, Texas, Green was a Houston newspaperman from 1901 until 1907, when he was admitted to the bar. He was appointed assistant criminal district attorney for Galveston and Harris counties in 1910 and was U. S. Attorney for the Southern District of Texas from 1914 to 1919, after which he left government work. He became assistant general attorney for Gulf and in 1929 he was named general attorney.

»

L. S. Cooper, purchasing agent for Gulf Oil Corporation, died November 13 at Houston.

»

Fred S. Brinkman, 54, Mid-Continent oil man, died November 12 in a Tulsa hospital following a brief illness. He had been a resident of Tulsa for 33 years, going there from Olpe, Kansas. Before World War I, in which he served, Brinkman was associated with The Carter Oil Company. Following the war he became an independent operator and was well known in the Mid-Continent area.

»

Judge A. Mills Ebright, 66, general counsel for Cities Service Oil Company, died October 16, at Bartlesville, Okla., after a brief illness. Ebright joined Cities Service in 1937.

»

Linn H. Barr, 72, retired engineer for The Texas Company at Tulsa, died October 13, at Rochester, Minn. He had been with the company since 1907, and retired about seven years ago.

»

Walter L. Rinaman, 63, Tulsa, superintendent of the land and geological department of Oklahoma Natural Gas Company, died October 14, following a heart attack. He had been with the company 32 years and prior to that time had been associated with Gem Oil Company, The Texas Company, and Gulf Oil Corporation.

»

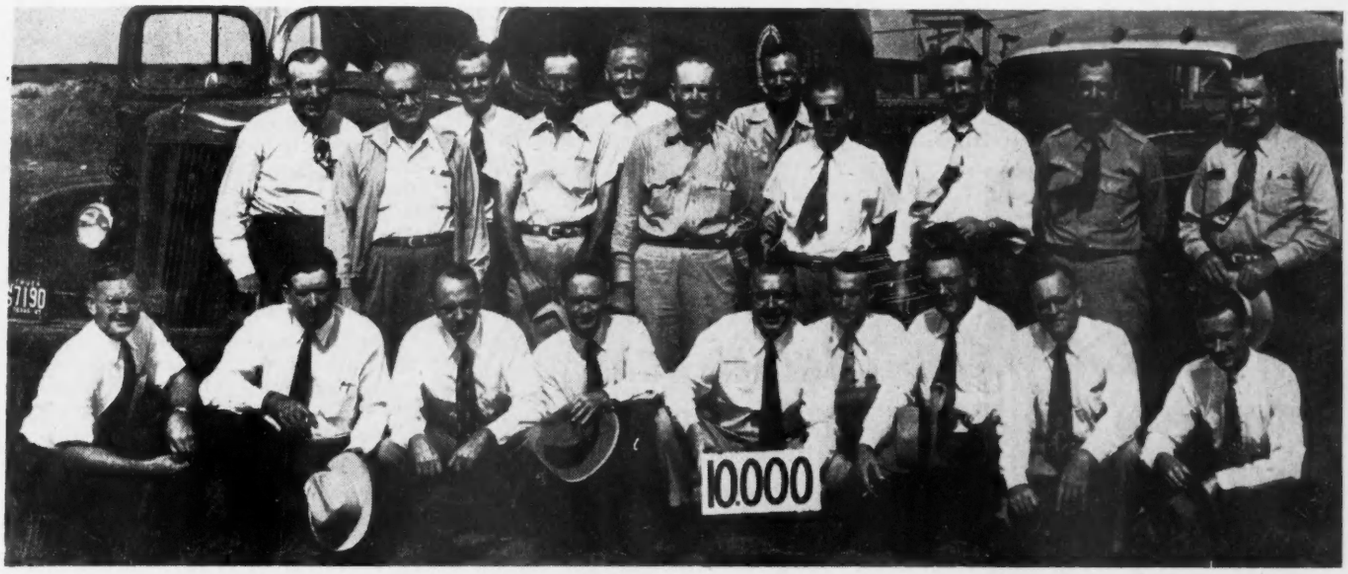
Emery A. Cook, 53, purchasing agent for Amerada Petroleum Corporation, died November 12 at Tulsa following a three-month illness. He was born at Norman and moved to Tulsa following his graduation from the University of Oklahoma.

»

James Robert Murray, pioneer Oklahoma oil man, died October 22 at Tulsa. He was 80 and had been retired for several years. He entered the oil business with Standard Oil Company of New Jersey at Bridgeville, Penn., and at the turn of the century was wildcatting for the Santa Fe railroad in Texas and Oklahoma.

MANUFACTURERS' and SUPPLIERS' Notes

Lane-Wells Company Runs 10,000th Radioactivity Log



Officials and guests on the occasion of Lane-Wells Company's 10,000th radioactivity well log. Standing, left to right, are Rodney S. Durkee, president, Lane-Wells, Los Angeles; John B. Goodrich, division production superintendent, Magnolia Petroleum Company, Houston; C. F. Ludwig, Gulf Coast Division sales manager, Lane-Wells, Houston; George Faulks, farm boss, Magnolia, West Ranch field, Texas; James D. Hughes, general sales manager, Lane-Wells, Los Angeles; T. M. Melton, tool pusher, Magnolia, Vanderbilt, Texas; C. B. Mitcham, hoist operator, Lane-Wells, Houston; Bill Green, president, Wells Surveys, Inc., Tulsa; R. B. McCullar, Mid-Continent Division manager, Lane-Wells, Oklahoma City; R. B. Downing, Mid-Continent Division sales manager, Lane-Wells, Oklahoma City; and H. D. Vaughan, district salesman, Lane-Wells, Corpus Christi, Texas. Front row, left to right, Charlie Duller, vice president, Wells Surveys, Inc., Tulsa; Clyde Turner, farm boss Magnolia, Lolita field, Texas; Phil Jennings, district geologist, Magnolia, Houston; Phil Davis, petroleum engineer, Magnolia, Houston; R. M. Rutledge, Jr., assistant Gulf Coast Division sales manager, Lane-Wells, Houston; Joe Myers, radioactivity operator, Lane-Wells, Houston; John J. Neale, Gulf Coast Division manager, Lane-Wells, Houston; Warren J. Jackson, petroleum engineer, Lane-Wells, Dallas; and John L. P. Campbell, division geologist, Lane-Wells, Houston.

The 10,000th radioactivity Well Log by Lane-Wells Company was run October 24 at Magnolia Petroleum Company's A-246, West Ranch field, Jackson County, Texas. Officials of both companies gathered at the well-site to celebrate the passing of a milestone in the progress of technical oil field services.

The 10,000 wells logged by Lane-Wells represent over seven years of experience and performance, during which experimentation and research has continued. As a result of this experience, experimentation and research, new field units, using the most advanced equipment, have been planned and built and are available to the industry today from over 40 field locations.

Radioactivity well logging was conceived in 1938 by the engineers of Engineering Laboratories, Inc., and was used commercially for the first time in 1940 at Polo field, Oklahoma, by Wells Surveys, Inc., a separate concern set up by the developers to continue the development and exploitation of the device. Several months after its initial use Lane-Wells was exclusively licensed to offer this survey service throughout the U. S. and Canada.

Republic Supply Company Moves General Offices Headquarters

Republic Supply Company has moved its general offices and district sales office from the Petroleum Building to the recently enlarged National Standard Building, Main and McKinney, streets, Houston. Republic has maintained general headquarters in the Petroleum Building for 19 years.

In its new quarters, Republic's organization will be located on the 12th, 13th, and 14th floors. General sales and executive offices will occupy the 12th and 13th floors with district sales offices on 14.

During the past several years Republic has added a number of new supply stores and sales offices throughout the Midwest area and now serves the oil industry from 50 sales and service points ranging from Chicago to South Texas and Mississippi to Colorado.

R. S. Huxtable Named Executive Vice President of Fawick Firm

Fawick Airflex Company, Inc., Cleveland, announced the appointment of Richard Scott Huxtable as executive vice president and general manager. Prior to his new appointment, he was assistant to George W. Codrington, vice president and general manager of the Cleveland Diesel Engine Division of General Motors Corporation.

R. S. Huxtable

Huxtable became connected with the Cleveland Diesel Engine Division, then the Winton Engine Corporation, in 1934. He had been with that concern continuously, holding important positions.

Venezuela Representative Named By International Goodrich Firm

John Reid III, International B. F. Goodrich Company, a division of the B. F. Goodrich Company, Akron, Ohio, has been assigned as special representative in Venezuela, Netherlands West Indies, the Guianas, with temporary headquarters at the Queens Park Hotel, Port of Spain, Trinidad.

He will represent the company in Industrial Rubber Products, Tires and Automotive Accessories. He resigned from the Navy early in 1947 to join the Goodrich company.

Joins Midwestern Staff

Clyde E. Bogle has joined the Tulsa staff of Midwestern Engine and Equipment Company as heavy equipment salesman.

Export Sales Manager Named by Templeton, Kenly & Company

J. B. Templeton, president of Templeton, Kenly & Company, Chicago, manufacturers of Simplex Jacks, announced that Haig C. Dilsizian, formerly vice president of the company, has been appointed exclusive manager of Templeton, Kenly export business.

Dilsizian's organization, functioning as an independent unit, will continue to operate from the company's former offices in the Graybar Building, 420 Lexington Avenue, New York City. He will concentrate on export activities, handling export sales and promotion of Templeton, Kenly and Company's Simplex Jacks for use in construction, oil and marine fields, the utilities, airways, railways, mines, and general industry.

E. A. Zimmerman has been assigned by Templeton, Kenly & Company as Eastern District sales manager for domestic sales. He formerly covered the New England, New York state, New Jersey, Washington and Baltimore areas under Dilsizian's direction. Zimmerman's offices and operating headquarters will also be at 420 Lexington Avenue, N. Y.

HUBER
PARAFFIN
SCRAPERS
MAKE YOUR SUCKER RODS YOUR PARAFFIN SCRAPER
Put an end to paraffin accumulation and the cost of steaming out or "passing rods" to free your wells of paraffin.
Huber Scrapers actually make the sucker rod string your paraffin removing agent. Attached to the rods, they constantly scrape the paraffin from the tubing wall as the rods reciprocate and rotate. The scrapers clear the tubing wall by a fraction of an inch so that paraffin is wiped off and pumped out before it can accumulate.
Equip your sucker rods with Huber Scrapers and stop costly paraffin troubles.
● they scrape while they rotate and reciprocate.
● require no servicing or attention.
● soon pay for themselves by saving work-over costs.
● hundreds of users report outstanding success of their operation.
ROTATING HEAD
This patented head automatically rotates the rod string a fraction of a turn on each stroke so that the scrapers wipe the wall free of paraffin.
ORDER FROM YOUR SUPPLY STORE
HUBER
PARAFFIN SCRAPERS
J. M. HUBER CORPORATION
BOX 831
BORGER, TEXAS

Houston District Salesman Named By Thornhill-Craver Company

Jack Loban, formerly of Edmond, Okla., where he represented the oil field chain division of Link-Belt Company, has been employed by Thornhill-Craver Company as salesman in the Houston district. Thornhill-Craver manufactures Unibolt products for the drilling, producing, pipe line, and refining divisions of the petroleum industry.

Jack Loban

El Campo, Texas, Store Opened By Continental Supply Company

The Continental Supply Company has opened a store at El Campo, Texas, under the management of D. F. Bell, formerly manager of the Raymondville, Texas, branch.

This point is under the supervision of W. G. Fitzpatrick, district manager, Houston.

G. W. Patterson has become manager of the Raymondville store, having been transferred from the store at Falfurrias, Texas, where he served in the same capacity. George M. Edge, formerly floorman at Falfurrias, has been named manager there.

Fairbanks, Morse Makes Changes In Sales Organization Personnel

Fairbanks, Morse & Company, Chicago, announced changed in its sales organization.

J. C. Elmburg, manager of the Boston branch house, has been transferred to the Atlanta branch to become manager in that area. He replaces G. N. Van Epps, resigned.

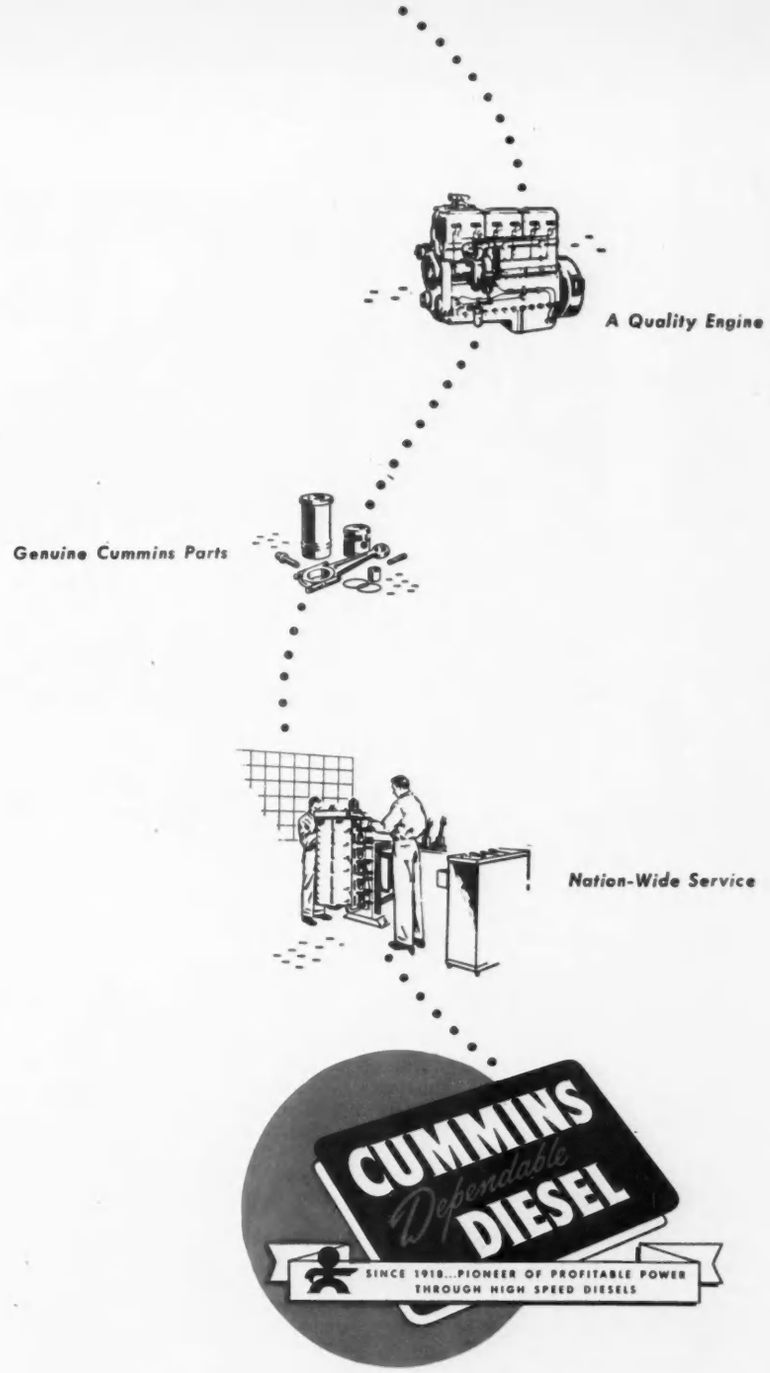
V. O. Harkness, who has been manager of the Diesel Division at Chicago headquarters has been appointed manager of the Boston branch, and T. M. Robie of Chicago has been appointed manager of the General Diesel Sales Division.

Oil Center Tool's Purchasing Agent Rose from Part-Time Job

Powell French, recently named purchasing agent for Oil Center Tool Company, Houston manufactruers, worked his way to that position from part-time draftsman in 1931. Before his recent promotion, French was chief engineer for Oil Center.

Powell French

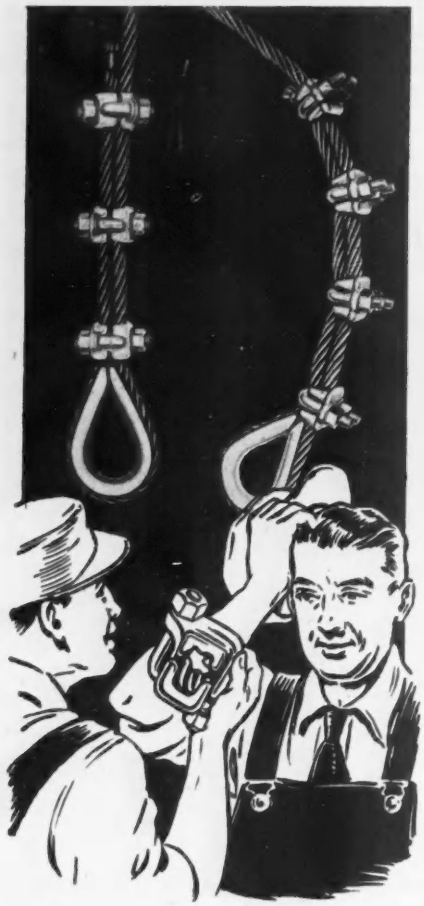
French, a Dallas native, has been connected with the oil well supply business since 1907, and with Houston firms since 1928. He went to work for Oil Center Tool at the height of the depression, making 30 cents an hour and working four hours each day as draftsman.



Protected Investment

Your investment in Cummins Dependable Diesels pays dividends because of their extra capacity for work . . . their low maintenance and fuel costs . . . their reliable performance with a minimum of downtime. Protection for your investment is assured by your Cummins dealer who makes available to you genuine parts, trained diesel mechanics and technical assistance no matter where or from whom your Cummins Dependable Diesel is purchased.

CUMMINS ENGINE COMPANY, INC. • COLUMBUS, INDIANA



"Get This Straight"

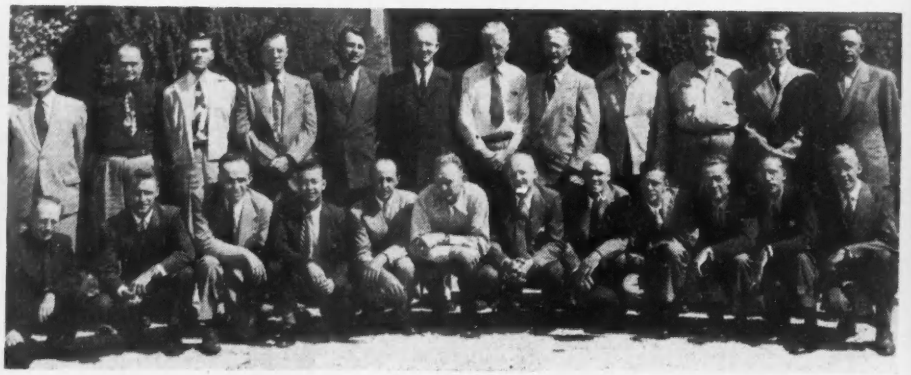
"A bowed rope is a weakened rope, Mac . . . those 'Finger Pinch' U-Bolt Clips crush and bend the rope . . . make the load *uneven* — some strands are overloaded . . . others don't carry their proper load. Results: premature rope failure . . . higher rope costs . . . lessened efficiency. Replace 'em with Laughlin 'Fist-Grip' Clips — they'll make your rope straight like *this* one, because their flat bearing surfaces give uniform pressure over the entire contact area. 'Fist-Grips' are easy to put on, too, Mac . . . even new men like yourself get 'em right the first time because they come in identical halves — you *can't* stagger 'em. Furthermore, three 'Fist-Grips' do the work of four U-Bolts, so you save time. Ask the Supply Room boys for 'Fist-Grips' . . . they prevent many a headache."

"Fist-Grip" Clips are available at your supply house. Look for the "L" trade-mark. Write for fitting catalog: Dept. 23, The Thomas Laughlin Co., Portland 6, Maine.

LAUGHLIN

THE MOST COMPLETE LINE OF DROP-FORGED WIRE ROPE AND CHAIN FITTINGS

Fred E. Cooper Sales Agents Meet



Front row, left to right: H. B. Appleton, secretary; Louis Gasche; H. B. Bloxom, sales manager; A. D. Brunk; R. B. Rubottom; J. A. Cott; E. Franks, Allis-Chalmers Manufacturing Company; B. S. Scott; Ray Kaib; E. E. Everson; A. T. H. Graham; E. Woolbert, engineer. Back row, left to right: Dave Fink; L. D. Morris, Fairbanks-Morse & Company; F. Richardson; J. W. Allen, shop superintendent; Harry R. Kramp; B. R. Wiggins; J. F. Hardin; C. F. Nelson; K. Flett, parts manager; Fred E. Cooper, president; H. E. Cooper, executive vice president; C. H. Hudson.

Appointment of H. B. (Buck) Bloxom as sales manager for Fred E. Cooper, Inc., was announced at the four-day sales meeting at the home offices.

Bloxom is one of Cooper's oldest employes in point of service, having joined the organization in 1929.

The Cooper meeting was divided into special discussion groups, schools of instruction and talks by specialists representing several manufacturers. A representative line of Allis-Chalmers well servicing units and power engines were used for demonstration and instruction purposes. The salesmen spent considerable time in the shop.

Training Film in Technicolor Available from Cameron Iron

"Quick Change" is the title of a new training film completed for Cameron Iron Works, Houston.

Filmed in technicolor and with narration, "Quick Change" illustrates the speed and simplicity of changing rams in the new Cameron Type "QRC" (Quick Ram Change) pressure operated blowout preventers.

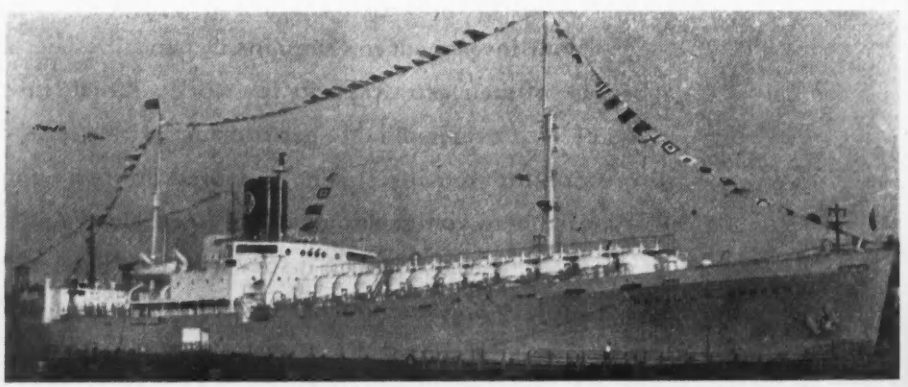
The film also demonstrates the step-by-step procedure of dismantling a Cameron "Flex-Seal" mud valve in the field, replacing its worn parts and reassembly, the entire operation requiring only ordinary rig tools and little time.

Several copies of the picture are now in the Cameron library and are available for showing to interested groups. Showing time is 20 minutes.

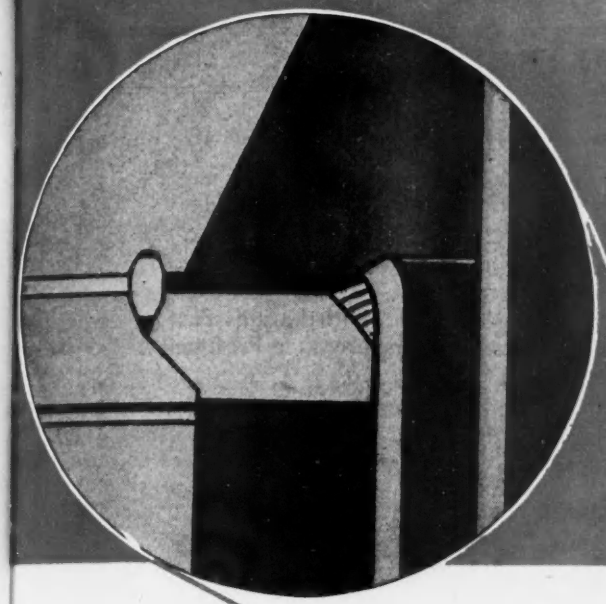
Geophoto Staff Enlarged

Recent additions to the staff of Geophoto Services, Denver, include E. C. Hutchinson and D. W. Schacht, formerly with the Bureau of Reclamation; R. L. Anderson, formerly with Chanslor-Canfield Midway Oil Company, Los Angeles; B. P. Harder, formerly U. S. Army photographic instructor; and E. G. Duckworth, formerly with the U. S. Geological Survey. All are employed as photogeologists.

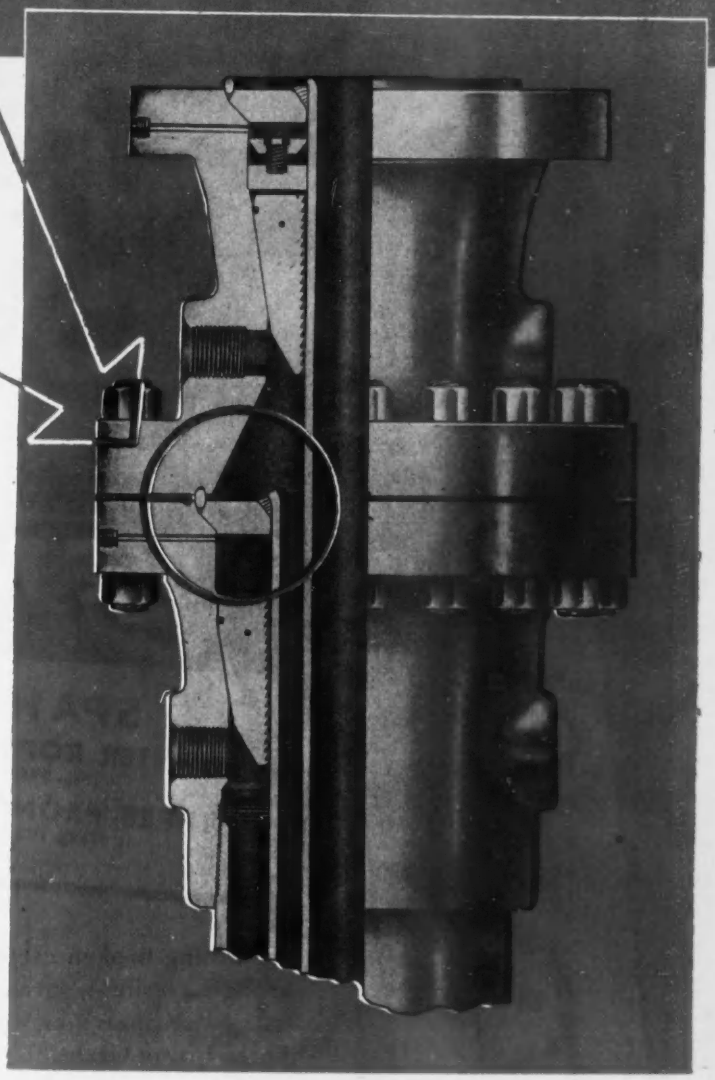
First Ocean-Going Ship of Its Kind



"The Natalie O. Warren," first ocean-going tank ship ever designed to transport propane or other liquefied petroleum gases, was launched at Beaumont. A former dry cargo vessel, the ship was converted for the use of Warren Petroleum Company.



CASING HEADS are no place for RESILIENT SEALS!



RECTORHEAD WELDED SEALS

- . . . *are permanent*
- . . . *never require changing*
- . . . *won't burn out*
- . . . *won't freeze*
- . . . *won't deteriorate*

Resilient packing ideally serves many needs of the Industry ... BUT A CASING HEAD SEAL IS NOT ONE OF THEM.

That's why RECTORHEADS employ the time-tested, field-proven, all-metal seal of a good weld plus API ring gasket.

RECTORHEAD welded seals do not contract and become brittle in freezing temperatures, as do resilient packings. Welded seals will not burn. RECTORHEAD welds do not require stress relieving ... (on numerous occasions RECTORHEAD welded seals have been tested to pressures 50% greater than test pressure of the head itself, without failure.) RECTORHEADS are designed and constructed so the regular welder on the rig can make the weld without special equipment, on any grade of pipe, every time, in one hour or less.

Unlike resilient packings, no RECTORHEAD welded seal has ever required maintenance or replacement during the life of the well.

Protect your well investment—use the ONLY permanent seal between strings of casing ... the RECTORHEAD welded seal.

RECTOR WELL EQUIPMENT CO., Inc.
FORT WORTH, TEXAS

Export: Lucey Export Corp., Woolworth Bldg., N.Y.C.
REPRESENTATIVES IN ALL ACTIVE FIELDS

RECTOR

RECTORHEAD

MAKING THE OIL INDUSTRY SAFER!

ASSOCIATION OF WELL HEAD EQUIPMENT MANUFACTURERS CERTIFIED

Awards Announced for Lincoln Design-for-Progress Program

The Trustees of The James F. Lincoln Arc Welding Foundation announced the awards in the firm's $200,000 Design-For-Progress program. The 467 awards ranged from $100 for honorable mention to $13,200 for the main award.

The first main award of $13,200 was divided among Paul F. Hackethal, chief engineer; Clarence C. Mast, shop superintendent, and Douglas W. Hamilton, welding foreman, all of the Koppers Company, Aeromatic Propeller Department, Baltimore, for their coauthorship of a paper entered in the Aircraft Classification. Their paper described how welded design of a variable pitch propeller hub for light planes overcame the problems presented by low cost manufacture and strength requirements to withstand repeated loads of thrust torque, centrifugal pull and gyroscopic action. The propeller has brought new safety, economy and speed to light private planes.

The second main award of $10,700 was awarded to Kiser E. Dumbauld, design engineer of the Bureau of Bridges of the Ohio State Highway Department, for his paper in the Structural Building and Bridges Classification. His subject was the redesign to welded construction of three of Ohio's bridges.

The third main award of $8200 went to G. J. Storatz, Engineer in Charge, the Heil Company, Milwaukee.

Nowery J. Smith Resigns Post As Parkersburg Vice President

Nowery J. Smith has resigned as vice president of Parkersburg Rig and Reel Company to devote full attention to the Nowery J. Smith Company which is specializing in the corrosion field as commercial hot dip galvanizers, electroplating, pickling and oiling of mill steel products.

Nowery J. Smith

The Nowery J. Smith Company has been appointed Southwest distributors and applicators for Amercoat corrosion resistant Vinyl and Thermo-setting plastic coatings. The company is also distributor of Amercoat Plastics to the petroleum industry in foreign fields.

Fifth Region Formed for Field Organization of Allis-Chalmers

Organization of a fifth region for the field organization of the Allis-Chalmers general machinery division under Arch J. Cooper, New York district office manager, has been announced by J. L. Singleton, vice president and director of sales. Formation of the first four regions was revealed earlier this year.

The new area, designated as the Empire region, will embrace territory now covered by New York, Buffalo, Rochester, Syracuse and Newark offices. The Rochester and Syracuse offices, formerly branch offices under the Buffalo district offices and the Newark office, formerly a branch of the New York district office, automatically assume district office status under the regional plan.

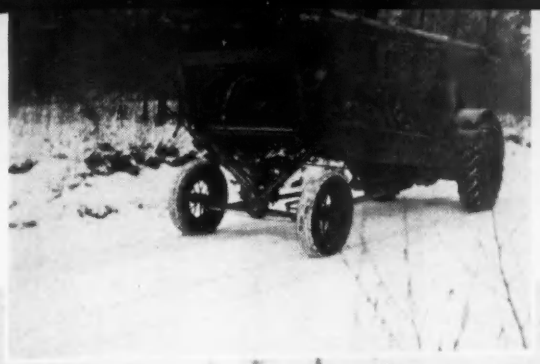
Cooper, who has been associated with Allis-Chalmers since 1909, continues as New York district office manager in addition to regional manager. Vernon L. Spinney, formerly New York petroleum sales representative, has been appointed assistant district office manager.

William J. Devers, formerly public utilities sales representative, New York district office, has been named Newark district office manager, while Ned W. Landis, formerly branch manager of the Syracuse office becomes a district manager. H. E. Weiss and Robert G. Burns continue as district manager of the Buffalo office and as special representative of the Rochester office, respectively.

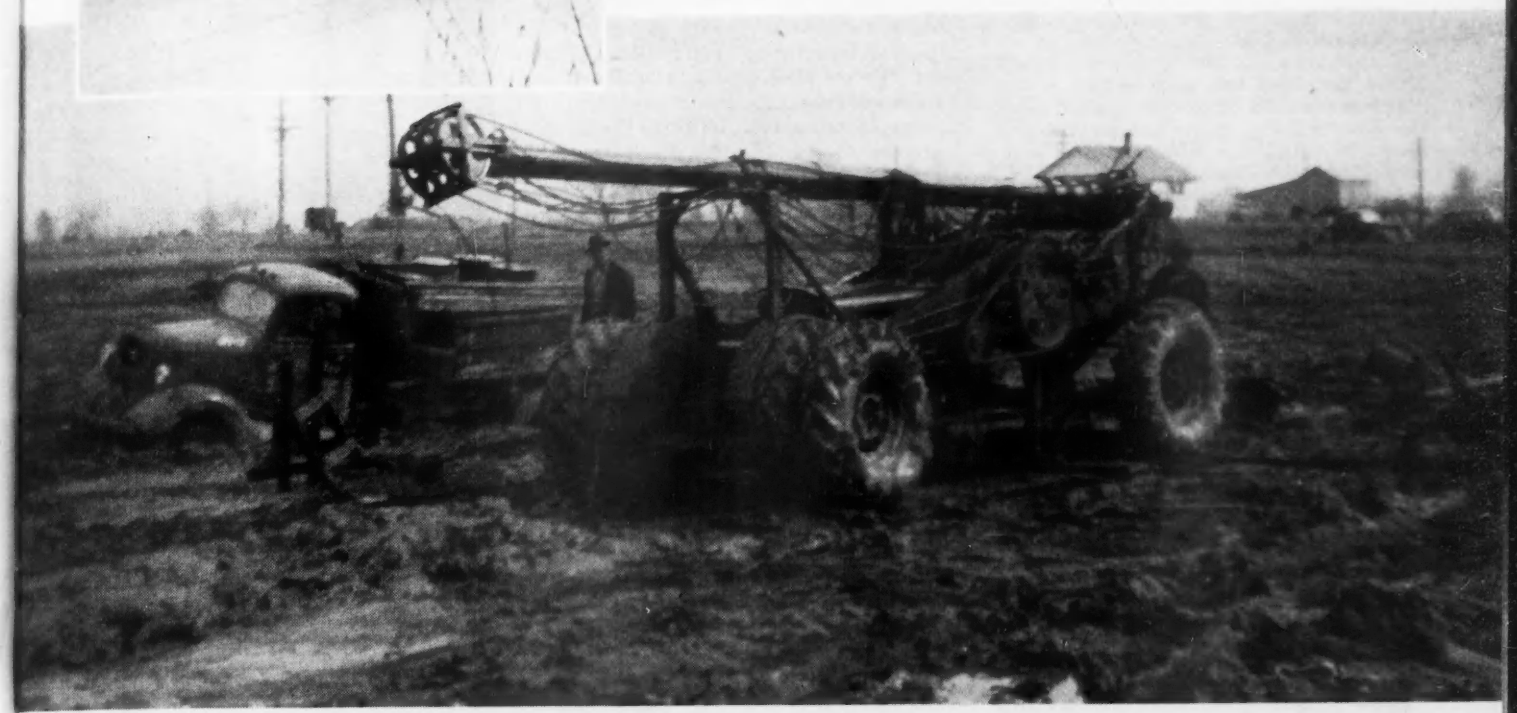
U. S. Steel Appointment Made

R. B. Scott has been appointed general accountant, U. S. Steel Corporation of Delaware, succeeding S. P. Smail, who has been elected comptroller and a director of the American Bridge Company.

SPECIFY
SPANG
FOR THE BEST IN CABLE TOOLS
SPANG
CENTER ROPE SPEAR
(Fig. F460)
THREE-PRONG GRAB
(Fig. F467)
For fishing broken cable and sand line, Spang furnishes a variety of Center and Side Rope Spears, as well as Two- and Three-Prong Grabs.
Strands of cable left attached to the rope socket may be removed with the Spang Drill Mill, or the Spang Drive Down Socket or Trimmer.
Fig. F460 Fig. F467
For the best in Cable Tools,
SPECIFY SPANG
THE HIGHER STANDARD
SPANG & CO.
BUTLER, PA.
YOUR DEALER SELLS SPANG TOOLS



The Rougher the Weather

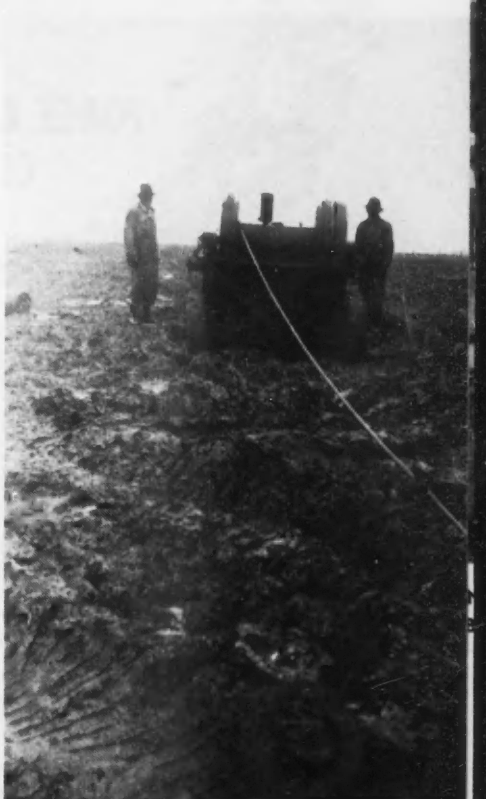


the more work you can do with Allis-Chalmers Units

High Road Speeds
Low Center of Gravity
High Road Clearance
Low Pressure Tractor Tires
Special Tractor Transmission
Slow Speed High Torque Engines

When weather and ground conditions get too bad for automotive type equipment, Allis-Chalmers–Fred E. Cooper Well Servicing Winch Tractors will keep right on going.

Mud, snow or sand won't slow down well servicing schedules, when leases are served with A-C Pulling Units.



A Cooper well servicing engineer will be glad to discuss the specifications of the FOUR sizes of winch tractors, and recommend the one most suitable for your work.

FRED E. Cooper, Inc. TULSA, OKLA.

Phone 5-7191 P. O. BOX 1890

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European Subsidiary Managers Attend Honeywell-Brown Meeting

The growing volume of industrial instrument sales in Europe, and prospects for accelerated business activity as industrialization on the continent moves ahead provided the main topics at the London meeting of foreign managers of the Brown Instrument Company and its parent organization, Minneapolis-Honeywell Regulator Company.

Holding its first international convention since the war, the company called into London managers and supervisory personnel of its five European subsidiaries to lay plans for expanded sales activity in the key market areas presently served by the Honeywell-Brown companies.

Called by Harold W. Sweatt, president, the meeting also was attended by Thomas McDonald, vice president in charge of sales, and William Westphal, manager of the International Division, all three of whom went to Europe to help the foreign managers outline forthcoming sales and production plans abroad.

H. A. Gehres

Ralph L. Boyer

Cooper-Bessemer Firm Announces Promotion of Top Executives

H. A. Gehres was named executive vice president and Ralph L. Boyer, vice president and chief engineer, for Cooper-Bessemer Corporation, Mount Vernon, Ohio, and Grove City, Penn.

Within the last three years the company's engineering division has come forward with a number of major developments in the engine and compressor-building field under the leadership of Gehres and Boyer.

Gehres joined the company in 1910 when it was known as the C. & G. Company. He became chief engineer in 1920 and a director in 1927. He was named vice president and director of engineering in 1935. Boyer, who joined Cooper-Bessemer in 1926 as diesel engineer, became assistant chief engineer in 1929 and chief engineer in 1938.

General Manager of Sales Named By Wickwire Spencer Division

H. C. Allington has been appointed general manager of sales for Wickwire Spencer Steel Division, The Colorado Fuel and Iron Corporation, with offices in New York City.

Allington has been engaged in sales work in the eastern area since the close of World War I. He joined Wickwire Spencer in 1943 to manage a new products department, but within a few months was selected assistant general sales manager.

Tulsa Service Organization for Pipe Line Industry Is Organized

A service organization for the pipe line industry was announced with the formation of the M. J. Crose Manufacturing Company, Inc., 2715 Dawson Road, Tulsa. The corporation was formed to develop, manufacture and service pipe line construction equipment.

The firm now manufactures internal lineup clamps, expanders, pipe line cleaning and priming machines, coating choppers, road boring machines, coating conveyors, coating strainers, and other pipe line construction equipment. This equipment is available from the new organization on a rental or outright sale basis.

M. G. McCool Named Vice President Of American Iron, Machine Works

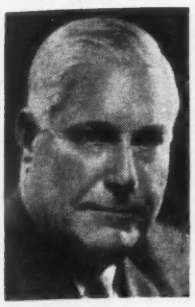
Earl W. Miller has resigned as general manager of American Iron and Machine Works, Oklahoma City, and M. G. McCool has been named executive vice president and general manager.

Regan
Forge & Engineering Co.
Quality
SAN PEDRO, CALIFORNIA;
HOUSTON, TEXAS, U.S.A.

Telephone, Bakersfield 34204
BAKERSFIELD, CALIFORNIA

EXCLUSIVE MID-CONTINENT REPRESENTATIVES: Hunt Tool Company, P. O. Box 1436, Houston, Texas
EXCLUSIVE EXPORT REPRESENTATIVES: Hunt Export Company, 19 Rector Street, New York City, N. Y. • Avda Pte. R. Saenz, Pena 832, Buenos Aires, Argentina

MANUFACTURERS' AND SUPPLIERS' NOTES



D. F. Axelson

R. M. Pease

D. F. Axelson Leaves Axelson Firm After 40 Years of Service

J. C. Axelson, president and general manager of Axelson Manufacturing Company, announced the retirement and resignation of D. F. Axelson, formerly vice president in charge of manufacturing.

Victor Mancuso

D. F. Axelson's retirement marks the close of about 40 years' association with the company, founded in 1892 by his father and uncle.

Axelson's retirement has resulted in the promotion of R. M. (Bob) Pease, formerly vice president and assistant general manager. Pease is now headquartered at the main plant in Los Angeles.

Also promoted in the Axelson organization is Victor (Vic) Mancuso, formerly works manager, to the position of vice president in charge of manufacturing.

Pease joined the Axelson organization in 1917. Mancuso has an uninterrupted service record with the company since 1919.

Enlarged Warehouse in Houston Opened by Rochester Ropes

Rochester Ropes, Inc., Culpepper, Va., has opened a new and enlarged warehouse for wire rope at Houston.

E. E. Lambert is Southwestern manager in charge of the warehouse, which is at 3115 Polk Avenue.

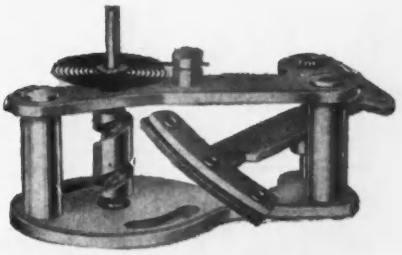
Rochester Ropes has installed reeling and cutting machinery in the Odessa, Texas, warehouse, which is under the direction of Paul Murray. The firm also maintains a mill depot at 29th and Byers Street, Oklahoma City, under the direction of J. S. Blackman.

Wheatley Names Manager

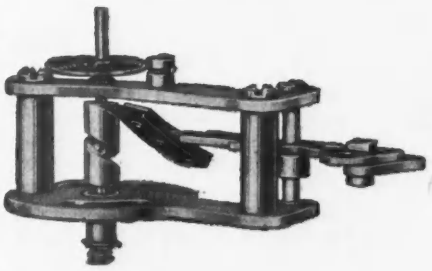
M. J. (Tiny) Bridges has joined the sales organization of Frank Wheatley Pump and Valve Manufacturers as district sales manager for Texas, according to Frank Wheatley, Jr., vice president and general manager. Bridges will headquarter at Fort Worth.

Do You Prefer A Right or Left Hander?

Helicoid Pressure Gages are made with either a right-hand movement or a left-hand movement—whichever is best for the service. Each movement offers an exclusive advantage not possible with any ordinary spur gear movement.



WITH THE RIGHT-HAND MOVEMENT, the cam releases from the roller just after the maximum dial pressure is reached. Thus, any over-pressure in the gage will do no harm whatever. Even the accuracy of the gage won't be affected provided the elastic limit of the Bourdon tube isn't exceeded.



WITH THE LEFT-HAND MOVEMENT, the cam releases from the roller just below the minimum dial graduation. Thus, any under-pressure, such as sudden vacuum, will do no harm whatever. The left-hand movement is ideal for hydraulic press gages or for sudden or violent pressure drops.

Only the Helicoid Movement has these advantages. And only Helicoid Gages have the Helicoid Movement.

ACCO

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE
Bridgeport 2, Connecticut

Appointment of Seven District Managers Announced by Baker

Baker Oil Tools, Inc., has appointed additional district managers as follows: C. J. Berlin, Dallas District with headquarters at Dallas; E. F. Hannon, Texas Gulf District with headquarters at Houston; H. F. Harper, Southwest Texas District, with headquarters at Corpus Christi; A. K. Kline, Olney District with headquarters at Olney, Ill.; G. E. Turner, Louisiana Gulf District with headquarters at Harvey, La.

R. C. Glover will continue as district manager of the Tulsa District; and R. D. McBrian will continue as district manager of the West Texas District with headquarters in Odessa.

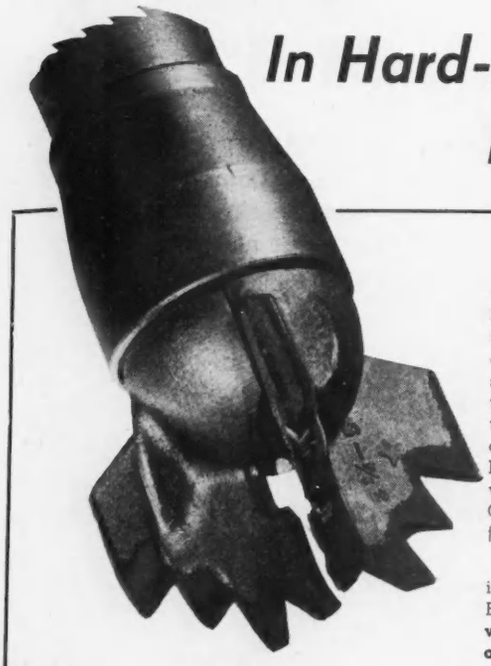
All have service records of from seven to 15 years with Baker.

Jarecki Executive Returns

W. Howard Pape, vice president of Jarecki Manufacturing Company in charge of the Oil Field Supply Division, has returned to his Houston headquarters from a combination business and vacation trip to several Latin American points. His trip, taken by air, embraced several cities in Guatemala and Mexico, including Mexico City.

A *NEW* BLADE FOR *HIGHER* EFFICIENCY

In Hard-Area Shot Hole Drilling



Type "AC" Assembly for "N" or API Rod

Type "DB" Assembly for "A" or "N" Rod

Here's really good news for you folks who've been using Hawthorne Bits . . . **It's a new blade that will cut hard formations as efficiently as any roller bit.** Its especially designed cutting edges are shaped so that each edge does a proportionate share of work . . . **never** at any time is the full cutting load imposed upon any one blade or section of one blade. Hard formation is removed in small chips which are easily circulated to the surface. Cutting edges, of course, are hard-faced for long service.

These new "Rock Cutter" Blades will interchange with standard Hawthorne Blades, however, **"Rock Cutter" Blades will cut soft formations just as efficiently as the standard blades,** so you don't have to change bits when you run out of hard digging.

For you folks who **haven't** been using Hawthorne Bits . . . get acquainted with them immediately. You'll like the economy, convenience and dependability they offer . . . and you'll like the way they lower your "bit costs per foot drilled."

AVAILABLE IN TWO MODELS

Type "AC" Assembly accommodates interchangeable blades in 3¾", 3⅞", 4", 4¼", 4½", 4¾" and 5" sizes. Type "DB" Assembly takes interchangeable blades in 3", 3¼", 3½", 3¾", 3⅞" and 4". **For highest efficiency, Type "DB" Assembly is recommended for use with 4" and smaller blades.**

Herb J. Hawthorne

P. O. BOX 7299 **HOUSTON 8, TEXAS**

Houston Manager Appointed by American Iron, Machine Works

Bryan Curtis has been appointed district manager at Houston for American Iron & Machine Works Company. Curtis joined the firm in 1936 and has been a representative at New Iberia and Harvey, La., Corpus Christi and Monahans, Texas, Oklahoma City, and was more recently field representative of the Houston office.

Bryan Curtis

J. J. Sloan will succeed Curtis as field representative out of the Houston office. **R. A. Feemaster** also has been transferred to Houston as city sales representative. Both were previously special representatives of the Oklahoma City office.

Otis Engineering Inaugurates Management-Employe Dinners

Otis Engineering Corporation has inaugurated a series of monthly management-employe dinners to familiarize both departments with the specific functions of the entire organization.

At the first of these meetings at Dallas, service pins were presented and H. C. Otis, president of Otis Engineering, reviewed the historical background of the company. H. C. Laird, general manager, explained the purpose of the meetings and the operation of the company from a management standpoint.

Westinghouse Executives Named

John E. Payne, formerly manager of industrial sales, has been named manager of all industry sales departments for the Westinghouse Electric Corporation, with general overall responsibility for sales of equipment to all industries.

R. S. Kersh, who has been manager of the company's Houston office since 1942, was named manager of industrial sales to succeed Payne.

Both will be located at the Westinghouse East Pittsburgh, Penn., plant.

WECO Representative Moves

J. W. (Bill) Rowell, WECO sales representative, has moved his headquarters from Marshall, Texas, to Monroe, La., according to G. R. Winder, vice president and sales manager, Well Equipment Manufacturing Corporation, Houston.

J. W. (Bill) Rowell

Rowell covers the East Texas, North Louisiana, South Mississippi and South Arkansas fields and his move to the Monroe location is designed to give better service to WECO equipment users in that area.

WEST TEXAS-NEW MEX
OIL FIELDS AN

Published as a supplement to W

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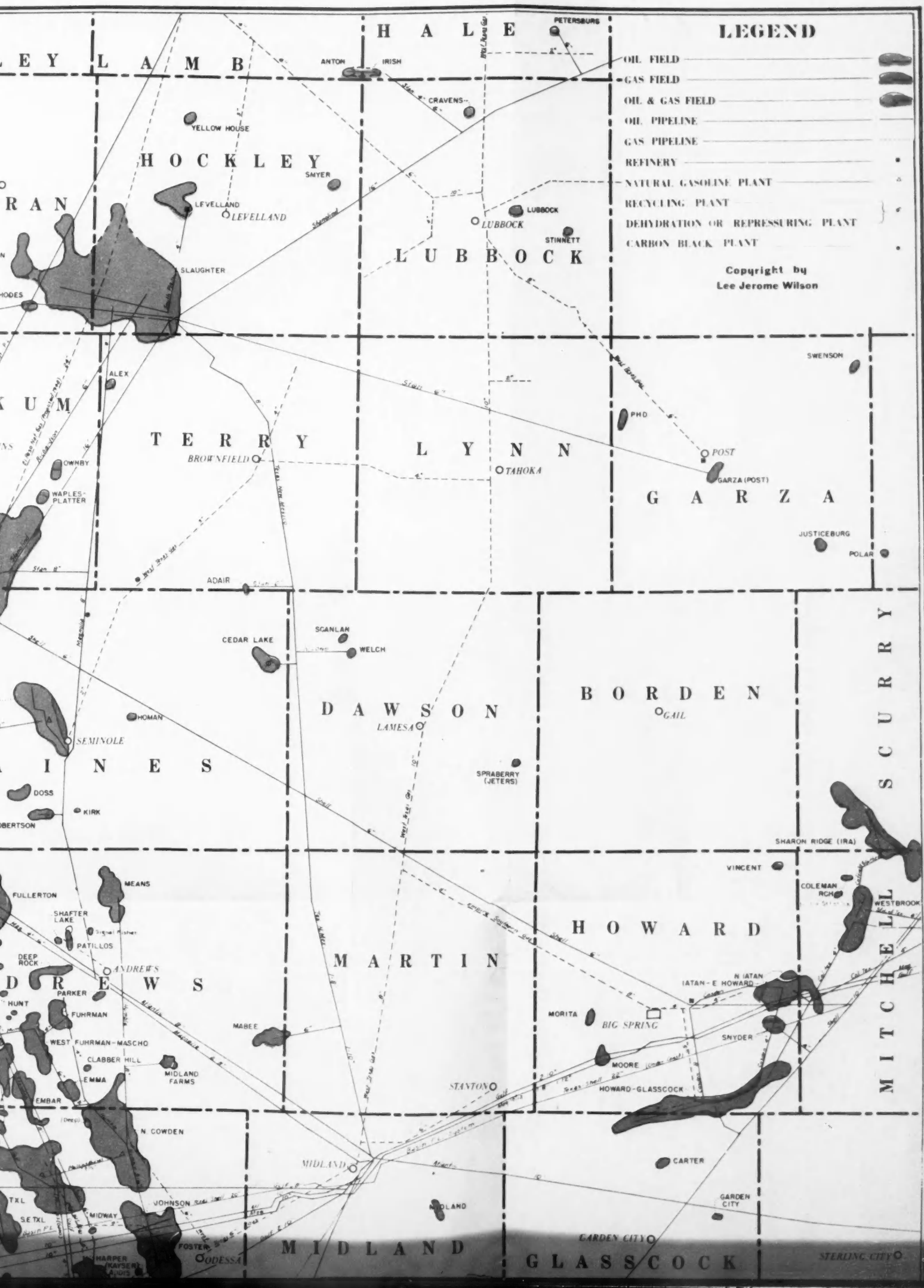
EXICO PERMIAN BASIN
AND PIPE LINES

to WORLD OIL issue of October, 1947



PRUITT
MAGNOLIA SEALY
N. WARD-ESTES
MONAHANS

Y O A K U M

BRAHANEY
PLAINS
WEST
WASSON
JONES RCH.
RUSSELL
SEMINOLE
HOBBS
RILEY
DOSS
ROBERTSON
UNION
FULLERTON
DEEP ROCK
HUNT
BLK. 12
MARTIN
W. ANDREWS
BEDFORD
THREE BAR
DOLLAR HIDE
EMBAR
ANDECTOR
N. GOLDSMITH
GOLDSMITH
TXL
SE TXL
MURCHISON
PENWELL

L E A

LOVINGTON
W. LOVINGTON
VACUUM
CAPROCK
HENSHAW
SQUARE LAKE
GRAYBURG-JACKSON
HIGH LONESOME
S. HIGH LONESOME
FORREST
DAUGHERITY
RED LAKE
Artesia
ANDERSON CAVE
EMPIRE
ROBINSON
N. MALJAMAR
ROBERTS
MALJAMAR
S. MALJAMAR
CORBIN
YOUNG
ATOKA
Dayton
DAYTON
E. DAYTON
LOCO HILLS
PREMIER
PALMILLO
LEO
N. SHUGART
ARTESIA
CULWIN
SHUGART
WATKINS
TURKEY TRACK
W. LUSK
BENSON
LUSK
E. LUSK
TONTO
MC MILLAN
BURTON
RUSSELL
SCANLON
PCA
HALE
GETTY
BARBER
HALFWAY
SALT LAKE
N. LYNCH
LEA
LYNCH
EUNICE-MONUMENT
W. EUNICE
SAN SIMON
FENTON
CARLSBAD
SOUTH EUNICE
ARROWHEAD
DRINKARD
HARRISON
NELSON
S. FULLERTON
HARDY
EIGHTY-FOUR
BRUNSON
Eunice
PADDOCK
FEDERAL JONES
PENROSE-SKELLY
BLINEBRY
SIMS
SKAGGS
N. SKAGGS
CASS
COOPER-JAL
LANGLIE-MATTIX
BLACK RIVER

E D D Y

A N D R

MASON
ORLA
L O V I N G
WHEAT
MENTONE
PRUITT
MONROE
HAYES
LION
PYOTE
ANTHONY
WILSON
SPENCER
BARSTOW
PECOS
SCOTT
BYRD
ESTES
S. WARD
SHIPLEY
W. SAND HILLS
DOBBS
SHIPLEY (SIL)
NICHOLS
NETTERVILLE
PAYTON
GRASSROOTS
JANISON-POLLARD
PECOS VALLEY
HEINER
LEHN
RICHARDS
FT. STOCKTON
FORT STOCKTON
CHANCELLOR
DUBLIN, ELLEN
EAVES
RHODES
SCARBOROUGH
LECK
KEYSTONE-ELLEN
KEYSTONE-LIME
HENDERSON
KERMIT
KEYSTONE-COLBY
WHEELER
HENDRICK
EMPEROR DEEP
WEINER
EMPEROR
HALLEY
N. MONAHANS
LOWE
SEALY-SMITH
MAGNOLIA-SEALY
N. WARD-ESTES
MONAHANS
S. MAG. SEALY
S. MONAHANS

W I N K L E R

W A R D

C U L B E R S O N

R E E V E S

P E C

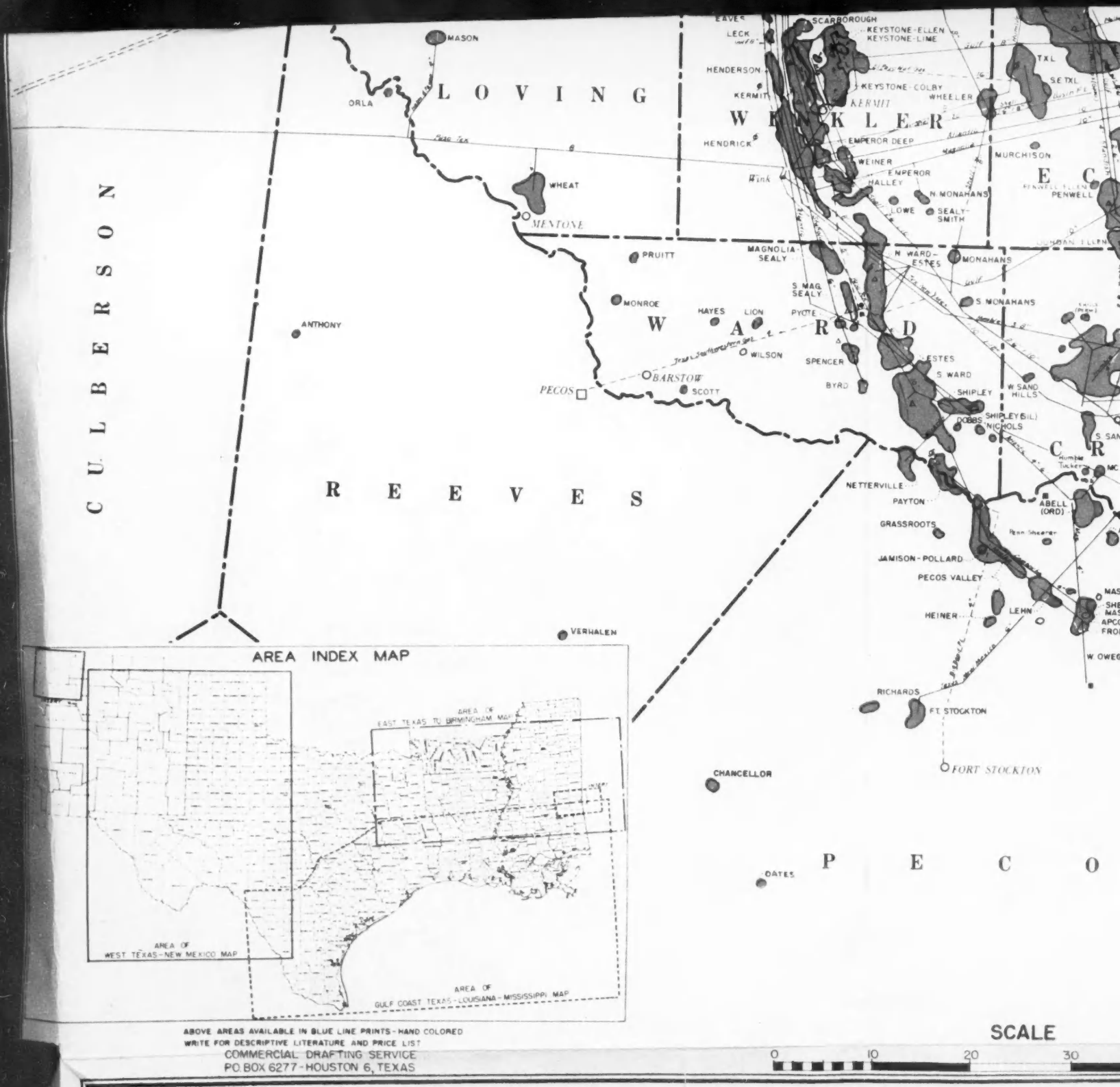
DATES

VERHALEN

AREA INDEX MAP

AREA OF EAST TEXAS TO BIRMINGHAM MAP

JORDAN
EDWARDS
ALEX
TERRY
BROWNFIELD
LYNN
TAHOKA
PHD
POST
GARZA (POST)
GARZA
OWNBY
WAPLES-PLATTER
JUSTICEBURG
POLAR
ADAIR
CEDAR LAKE
SGANLAN
WELCH
DAWSON
LAMESA
BORDEN
GAIL
SCURRY
HOMAN
SEMINOLE
SPRABERRY (JETERS)
DOSS
KIRK
SHARON RIDGE (IRA)
VINCENT
COLEMAN RCH
WESTBROOK
MEANS
SHAFTER LAKE
PATILLOS
HOWARD
MARTIN
ANDREWS
PARKER
FUHRMAN
MABEE
N. IATAN
IATAN-E. HOWARD
MORITA
BIG SPRING
SNYDER
WEST FUHRMAN-MASCHO
CLABBER HILL
EMMA
MIDLAND FARMS
MOORE
HOWARD-GLASSCOCK
STANTON
MITCHELL
N. COWDEN
MIDLAND
CARTER
GARDEN CITY
MIDWAY
JOHNSON
FOSTER
ODESSA
GARDEN CITY
GLASSCOCK
STERLING CITY
HARPER (KAYSER)
S. COWDEN
STERLING
DOURO
JORDAN
EDWARDS
WADDELL
ELLA-WADDELL
UNIV.-WADDELL
DUNE
SAND HILLS
(CHURCH FIELDS)
BLK 31
MC ELROY (GULF MC ELROY)
CRANE
BARNSLEY
S. SAND HILLS
UPTON
UPLAND
STILES
REAGAN
IRION
MC KEE
CRANE-COWDEN
OWENS
ABELL (PER.)
HERRINGTON
RANKIN
BIG LAKE
MC CAMEY
HURDLE
N.W. GRAYSON
GRAYSON
Big Lake
BARNHART
Barnhart
MASTERSON, DEEP
SHEARER
MASTERSON
APCO WARNER
FROMME
CROSSETT
WEBB RAY
W. OWEGO
MC CANDLES
CROCKETT
WORLD-POWELL
WENTZ
MAC DER
MULE CR.
TOBARS
BLK 39
WALKER
YATES
NOELKE
TURNER
SHANNON
MIDWAY LANE
MITCHAM
SHANNON-GRAYBURG (LIVE OAK)
TODD DEEP
WYATT
BEAN
TAYLOR-LINK
McKENZIE
WHITE & BAKER
OLSON
SIMPSON
WOLFCAMP
HOOVER
CLARA COUCH
OZONA
LANCASTER MILL
O S



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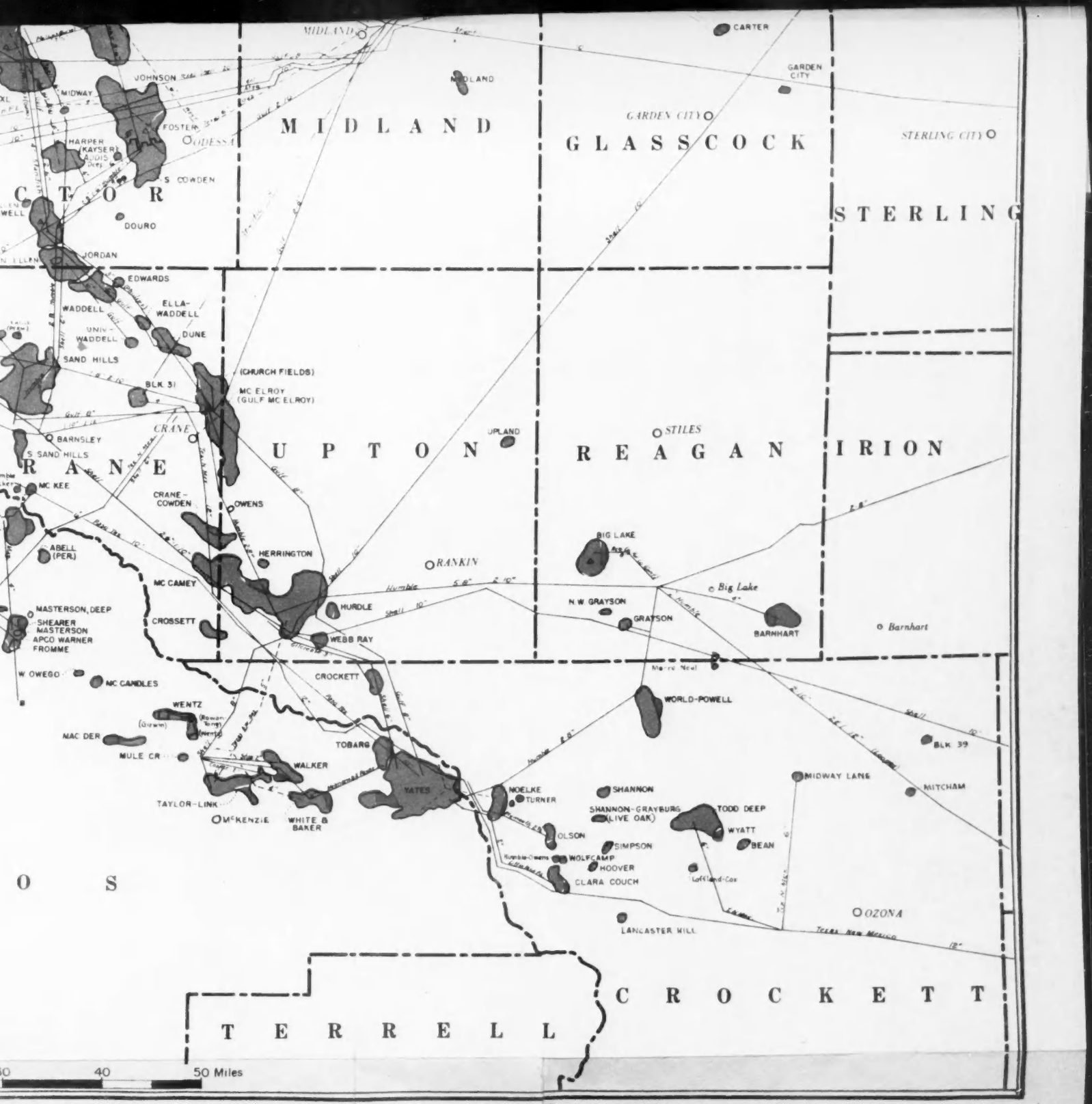

MIDLAND
MIDLAND
CARTER
GARDEN CITY
GARDEN CITY
STERLING CITY
MIDLAND
GLASSCOCK
STERLING
JOHNSON
MIDWAY
FOSTER
ODESSA
HARPER (KAYSER)
S. COWDEN
DOURO
JORDAN
EDWARDS
WADDELL
ELLA-WADDELL
UNIV.-WADDELL
DUNE
SAND HILLS
(CHURCH FIELDS)
BLK. 31
MC ELROY (GULF MC ELROY)
CRANE
BARNSLEY
S. SAND HILLS
MC KEE
CRANE-COWDEN
OWENS
ABELL (PER.)
HERRINGTON
MC CAMEY
MASTERSON, DEEP
SHEARER
MASTERSON
APCO WARNER
FROMME
CROSSETT
HURDLE
WEBB RAY
W. OWEGO
MC CANDLES
CROCKETT
WENTZ
MAC DER
MULE CR.
TOBARG
WALKER
TAYLOR-LINK
McKENZIE
WHITE & BAKER
YATES
UPTON
REAGAN
IRION
UPLAND
STILES
RANKIN
BIG LAKE
N.W. GRAYSON
GRAYSON
BARNHART
Big Lake
Barnhart
WORLD-POWELL
BLK. 39
MIDWAY LANE
MITCHAM
NOELKE
TURNER
SHANNON
SHANNON-GRAYBURG (LIVE OAK)
TODD DEEP
WYATT
BEAN
OLSON
SIMPSON
WOLFCAMP
HOOVER
CLARA COUCH
OZONA
LANCASTER HILL
CROCKETT
TERRELL
40
50 Miles

...1916...
...The OIL WEEKLY

WORLD OIL

...ECIALIZED FOR DRILLING, PRODUCING,
...E LINE OPERATIONS AND MANAGEMENT

...ertisers' Index page ... December 1947 ... Table of Contents page 39

FOR EFFICIENT FLUSHING ACTION

THIS PHOTOGRAPH ILLUSTRATES 450 GALLONS OF WATER PER MINUTE PASSI
THROUGH THE WATER COURSES OF A 9⅞" HUGHES TRI-CONE ROCK B

you can't beat a HUGHES ROCK BIT

HUGHES TOOL COMPANY HOUSTON, TEXAS

Standard of the Industry

Now—a real yardstick

FOR SELECTING OILFIELD ENGINE HORSEPOWER

BUDA Oilfield ENGINES

Here, for the first time, is a comprehensive attempt to show actual *usable* horsepower ratings for various oil field services. By referring to the following tables, any operator can tell at a glance just what power he *will get* from any BUDA Oilfield Engine Model…data never before offered by an engine manufacturer.

BUDA NATURAL GAS OIL FIELD ENGINE SERVICE RATINGS

Model	Maximum HP @ RPM	65% Production Pumping HP @ RPM	70% Pipe Line Pumping HP @ RPM	75% Mud Pumps HP @ RPM	80% Drilling Hoisting HP @ RPM	85% Well Servicing HP @ RPM
4-B-153	49 @ 2800	22 @ 1600	24 @ 1600	28 @ 1800	33 @ 2000	39 @ 2400
6-B-230	73.5 @ 3200	31 @ 1600	34 @ 1600	40 @ 1800	46 @ 2000	56 @ 2400
HP-326	79.5 @ 2600	37 @ 1400	40 @ 1400	48 @ 1600	55 @ 1800	62 @ 2000
K-428	108 @ 2400	48 @ 1400	52 @ 1400	62 @ 1600	72 @ 1800	83 @ 2000
L-525	113 @ 2400	57 @ 1400	61 @ 1400	72 @ 1600	83 @ 1800	93 @ 2000
LO-525	157 @ 2400	67 @ 1400	72 @ 1400	87 @ 1600	101 @ 1800	114 @ 2000
JL-1335	194.5 @ 1350	109 @ 1000	117 @ 1000	134 @ 1100	150 @ 1200	164 @ 1300
MO-893	188 @ 1800	100 @ 1200	107 @ 1200	128 @ 1400	141 @ 1500	150 @ 1800
PC-1879	242 @ 1200	142 @ 900	153 @ 900	175 @ 1000	192 @ 1100	206 @ 1200
6-PCG-1879†	340 @ 1200	172 @ 900	185 @ 900	220 @ 1000	256 @ 1100	289 @ 1200
PCS-1879*						

*Supercharged †Convertible

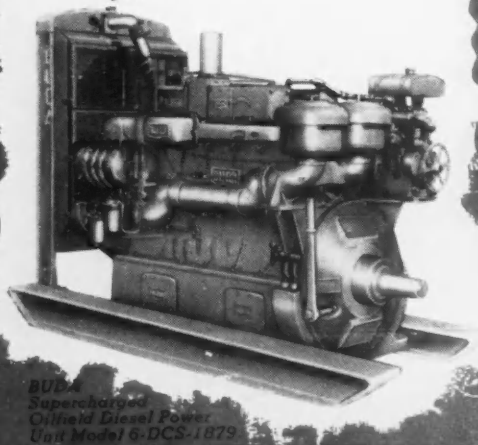
NOTE: Engine speeds shown for various types service are MAXIMUM recommended. Many operators prefer lower speeds for longer engine life. In these cases select desired engine operating speed and refer to Maximum HP shown on Buda oil field power curve and take percentage (%) of Maximum HP shown above for each type service. Ex: assume it is desired to operate Model HP-326 in "pipeline service" at 1200 RPM Power curve shows 50 BHP at this speed. Taking 70% of 50 BHP = 35 usable HP @ 1200 RPM.

BUDA DIESEL OIL FIELD ENGINE SERVICE RATINGS

Model	Maximum HP @ RPM	65% Production Pumping HP @ RPM	70% Pipe Line Pumping HP @ RPM	75% Mud Pumps HP @ RPM	80% Drilling Hoisting HP @ RPM	85% Well Servicing HP @ RPM
4-BD-153	40 @ 2400	20 @ 1600	22 @ 1600	26 @ 1800	29 @ 2000	33 @ 2200
6-BD-230	60 @ 2400	31 @ 1600	33 @ 1600	38 @ 1800	44 @ 2000	49 @ 2200
6-DT-317	90 @ 2300	44 @ 1600	48 @ 1600	57 @ 1800	65 @ 2000	77 @ 2200
6-DT-468	113 @ 2000	59 @ 1400	63 @ 1400	72 @ 1500	80 @ 1600	92 @ 1800
4-DC-645	119 @ 1400	62 @ 1100	67 @ 1100	78 @ 1200	83 @ 1200	101 @ 1400
6-DC-844	180 @ 1800	89 @ 1200	96 @ 1200	117 @ 1400	131 @ 1500	153 @ 1800
6-DCS-844*	225 @ 1800	109 @ 1200	117 @ 1200	145 @ 1400	164 @ 1500	192 @ 1800
8-DC-1125	240 @ 1800	119 @ 1200	128 @ 1200	157 @ 1400	176 @ 1500	204 @ 1800
8-DCS-1125*	300 @ 1800	145 @ 1200	156 @ 1200	194 @ 1400	218 @ 1500	255 @ 1800
6-DC-1879	258 @ 1200	140 @ 900	150 @ 900	174 @ 1000	198 @ 1100	218 @ 1200
6-PCD-1879†	330 @ 1200	174 @ 900	187 @ 900	218 @ 1000	251 @ 1100	281 @ 1200
6-DCS-1879*						

*Supercharged †Convertible

NOTE: Engine speeds shown for various types service are MAXIMUM recommended. Many operators prefer lower speeds for longer life. In these cases select desired engine operating speed and refer to Maximum HP shown on Buda oil field power curve and take percentage (%) of Maximum HP shown above for each type service. Ex: assume it is desired to pull "Mud pump" with Model 6-DC-844 operating at 1200 RPM Power curve shows 137 BHP at this speed. Taking 75% of 137 BHP = 102 usable HP @ 1200 RPM.



BUDA Supercharged Oilfield Diesel Power Unit Model 6-DCS-1879

BUDA

15436 Commercial Avenue
HARVEY *(Chicago Suburb)* ILLINOIS

WHEREVER THERE'S OIL, *there's Buda...* ENGINES AND SERVICE

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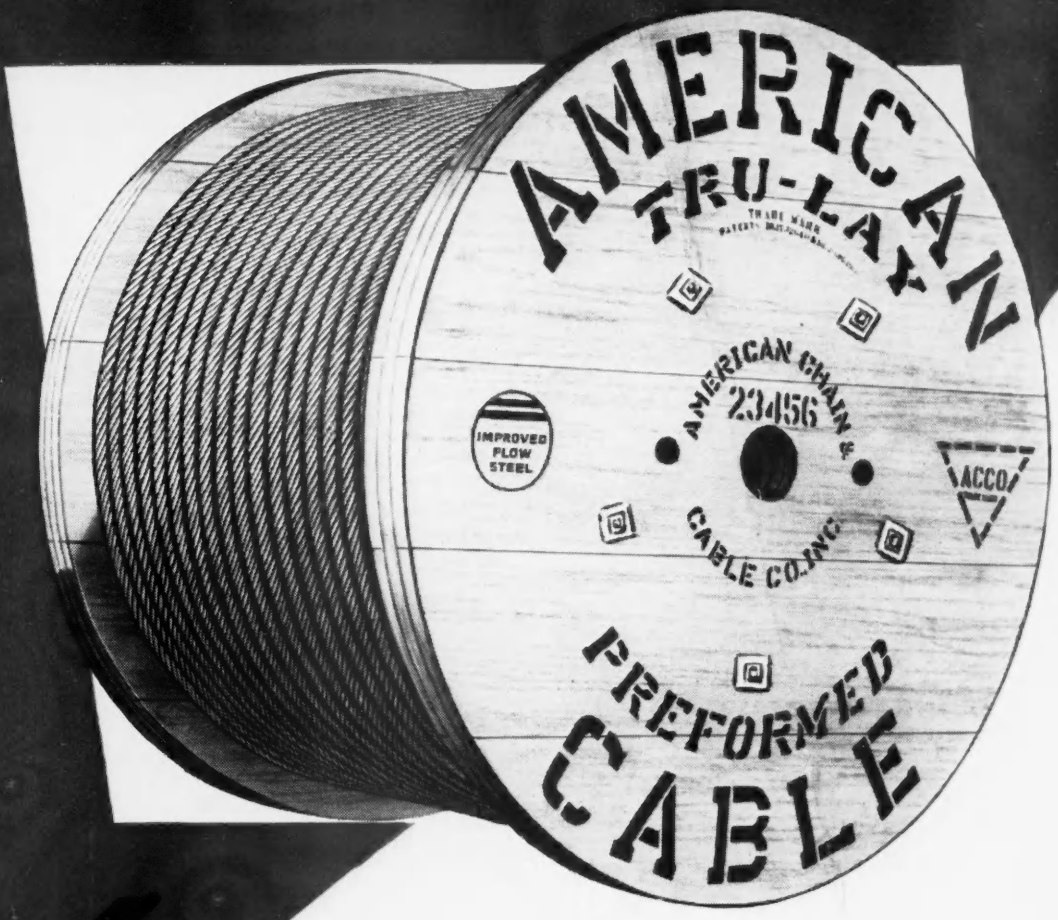
Denver • ILLINOIS • New York City (Export)

TRU-LAY *Preformed*



for ROTARY DRILLING LINES

If there is one thing required of a rotary drilling line, it is the ability to spool evenly. TRU-LAY spools evenly because it has so little tendency to whip. • You might call it "gilt-edge" wire rope . . . this TRU-LAY. It behaves on the draw works. It makes faster round trips. It cuts lost time in changing bits. And TRU-LAY resists rotating in sheave grooves . . . so both the line and grooves in traveling and crown blocks last longer. These are the advantages gained by Preforming TRU-LAY. • Add to this the strength provided by the toughest of Improved Plow Steel wires and you get a rope that will stand the gaff. Ask for TRU-LAY Preformed I. P. S.

Distributors in all strategic points

ACCO

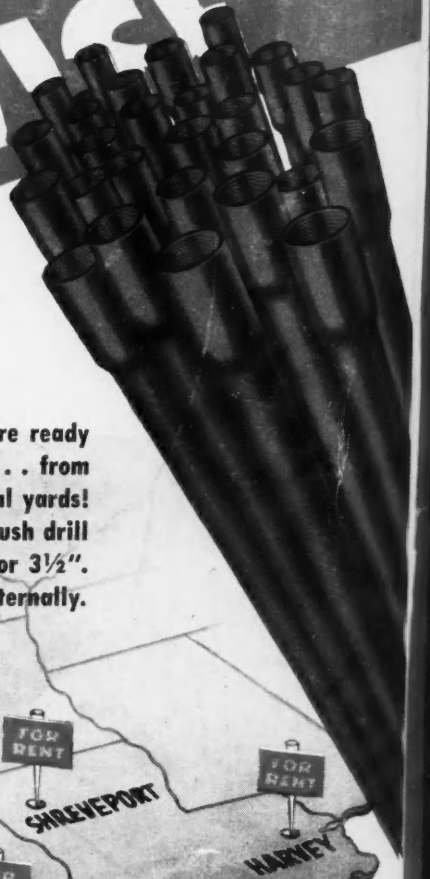
Wilkes-Barre, Pa., Chicago, Denver, Houston, Los Angeles, Pittsburgh, San Francisco, Bridgeport, Conn.

AMERICAN CABLE DIVISION
AMERICAN CHAIN & CABLE

In Business for Your Safety

Only AMERICAN *offers you this...*

COMPLETE RENTAL SERVICE



DRILL PIPE or DRILLING TOOLS . . . all are ready for immediate delivery on rental basis . . . from any of our six strategically located rental yards! OVER 90 MILES of first quality, internal flush drill pipe . . . available in sizes 2⅜", 2⅞", or 3½". Thoroughly inspected internally and externally.

2⅜", 2⅞" and 3½"

DRILL PIPE

DRILLING TOOLS include—

- American Drill Collars
- American Kellys
- Rotary Tongs
- Rotary Slips
- Elevators
- Core Barrels
- Safety Joints
- Blowout Preventers
- Rotary Subs

DAY OR NIGHT RENTAL SERVICE
at the following "American" Rental Yards: Shreveport and Harvey, Louisiana . . . Oklahoma City, Okla. . . . Houston, Alice and Odessa, Texas.

AMERICAN
IRON & MACHINE WORKS CO.
OKLAHOMA CITY, OKLAHOMA
Office, Houston, Texas
Export Office: 420 Lexington Ave., New York City, N.Y.

REMEMBER, THERE IS AN "AMERICAN" SERVICE MAN IN EVERY ACTIVE FIELD!